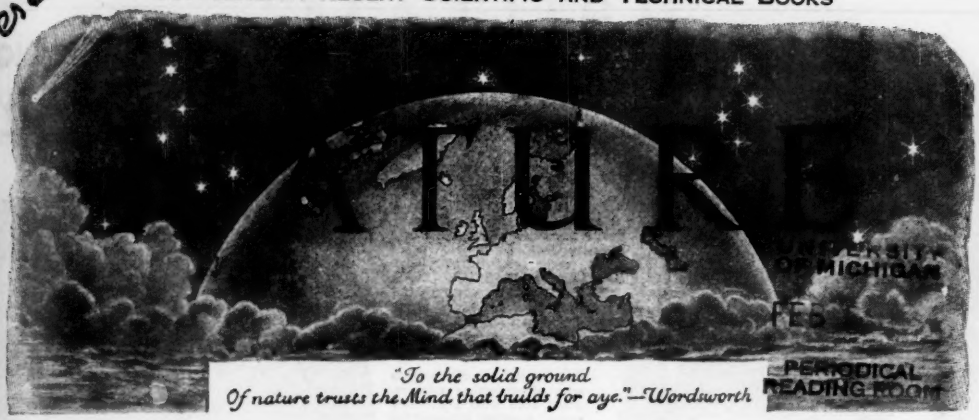
"NATURE", JANUARY 29, 1955

SUPPLEMENT: RECENT SCIENTIFIC AND TECHNICAL BOOKS



UNIVERSITY OF MICHIGAN
FEB
PERIODICAL READING ROOM

VOL. 175, NO. 4448 SATURDAY, JANUARY 29, 1955 TWO SHILLINGS

THE Newton

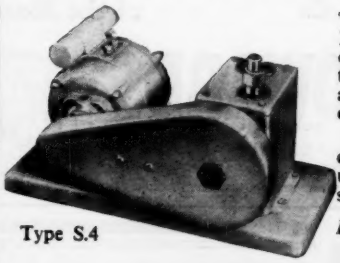
LONG WORKING DISTANCE ATTACHMENT

. . . provides a working distance of 12.8 mm. between object glass and specimen when fitted to a standard microscope in conjunction with a conventional 4 or 8 mm. objective.

A further important feature is that the use of this attachment eliminates image reversal and thus further facilitates examination and manipulation of specimens.

Write for further details to: Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17.
Member of the A.E.I. Group of Companies M/A 101

METROVAC PUMPS



Type S.4

Typical of the Metrovac range of rotary pumps, the Type S.4 has a displacement of 0.4 litres/sec.

Other models cover the range up to 33 litres/sec.

Please write for full details.

METROPOLITAN-VICKERS
ELECTRICAL CO. LTD. TRAFFORD PARK MANCHESTER

Member of the A.E.I. group of companies

VACUUM PUMPS

N/P402

Humidity Measurement & Control

Hair Element
Wet and Dry Bulb
Gregory Electrolytic

MERCURY-IN-GLASS
MERCURY-IN-STEEL
ELECTRICAL RESISTANCE

Methods

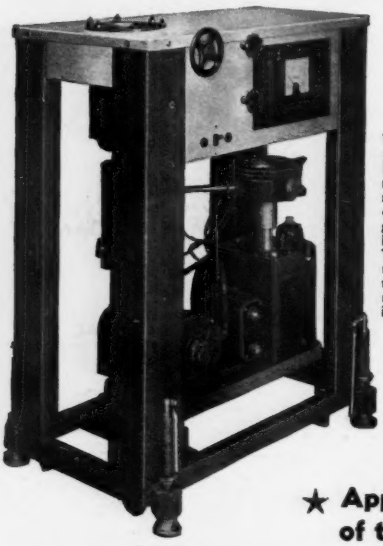
Send for List H/20: Post free

Negretti & Zambra, Ltd., 122 Regent St., W.1 REGent 3406

BRANCHES: *Birmingham · Cardiff · Glasgow · Leeds · Manchester · Nottingham*

AGENTS OVERSEAS: *Argentina · Australia · Belgium · Brazil · Canada · Czechoslovakia · Denmark Egypt · Eire · Finland · France · Greece · Holland · Iceland · India · Italy · New Zealand N. Ireland · Norway · Portugal · S. Africa · Spain · Sweden · Turkey*

Technical Service available in most countries.



★*Critical* VACUUM LEAK TESTING applied *ECONOMICALLY*

Working with critical vacuum processes or hermetically sealed instruments, such as mercury arc rectifiers, electron tubes, etc., slow leaks can prove extremely costly. Utilising a simple 'tracer-gas' technique, EDWARDS PALLADIUM - BARRIER LEAK TESTER is a highly accurate and reliable instrument with a sensitivity approaching that of the mass-spectrometer—but without its complications or expense.

Best results are obtained, as with all detection systems, when used with a pumping system specially designed for leak testing. Standard leak test pumping systems are manufactured by W. Edwards. Send for full details.

★ Approaching that of the Mass-Spectrometer

W. EDWARDS & CO. (LONDON) LTD

MANOR ROYAL · CRAWLEY · SUSSEX

CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

for better vacuum service

BRANCHES: GLASGOW & TORONTO. AGENTS THROUGHOUT THE WORLD

CASELLA LONDON

TEMPERATURE & HUMIDITY

— at a glance

THE IDEAL INSTRUMENT FOR USE IN OFFICE, STORE ROOM OR FACTORY

This Hair Hygrometer, which enables the relative humidity to be read accurately and quickly, can be fitted with either a Fahrenheit or Centigrade Thermometer.

IMMEDIATE DELIVERY

Price £4 19s. 0d.

For further details write to:

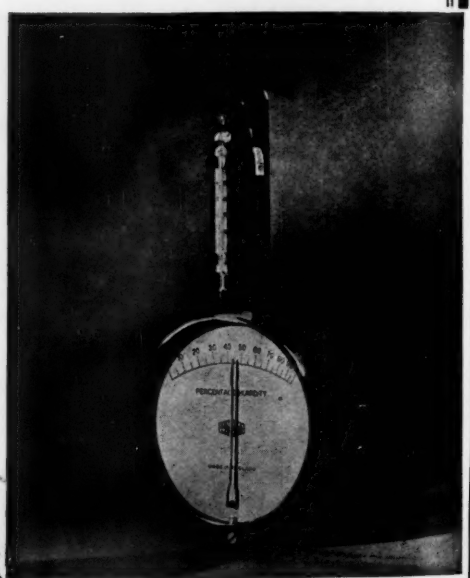
C. F. CASELLA & Co. Ltd.

REGENT HOUSE FITZROY SQUARE

LONDON, W.1

Telephone: ★EUSton 3944

Member Scientific Instrument Manufacturers' Association of Great Britain



NATURE

No. 4448 SATURDAY, JANUARY 29, 1955 Vol. 175

CONTENTS

	Page
University Education in Central Africa	181
Medical Bibliography and its Problems. By Dr. E. Ashworth Underwood	182
A Technological Approach to the Study of Bacterial Morphology. By Dr. K. A. Bisset	184
Colour Photography. By Prof. W. D. Wright	184
Presenting Modern Chemistry. By G. Fowles	185
The University of Malaya. By Sir Sydney Caine, K.C.M.G.	186
Recent Trends of Glacier Fluctuations in the North Atlantic Area. By Dr. M. M. Sweeting	188
British Cotton Industry Research Association : Annual General Meeting	190
Obituaries :	
Sir Arthur Keith, F.R.S. By Sir Wilfrid Le Gros Clark, F.R.S.	192
Mr. J. E. Sears, C.B.E. By Dr. H. Barrell	193
News and Views	193
Survey of Field Theory : Autumn Meeting of the Physical Society. By Prof. R. W. Ditchburn	197
The Geographical Association. By Prof. W. G. V. Balchin	198
Science Masters' Association : Annual Meeting at Newcastle upon Tyne. By W. H. Dowland	199
The British Flora during 1954. By J. E. Lousley	200
Hydraulic Transport of Coal. By Prof. H. Heywood	202
Recent Work in Mayan Archæology. By Dr. G. H. S. Bushnell	202
Effect of Streptomycin on Various Enzymes responsible for Syntheses and Degradations of Higher Saccharides. By Dr. S. A. Barker, Dr. E. J. Bourne, Prof. M. Stacey, F.R.S., and R. B. Ward	203
Exchange Reactions in the Entry of Cations into Plant Tissues. By R. Scott Russell and M. J. Ayland	204
Letters to the Editors :	
Analgesic and Antipyretic Activities of 4-Hydroxy*iso*phthalic Acid.—G. B. Chesher, H. O. J. Collier, F. A. Robinson, E. P. Taylor, S. E. Hunt, J. Idris Jones and A. S. Lindsey	206
Imidazole Complexes of Myoglobin and the Position of the Hæm Group.—J. C. Kendrew and R. G. Parrish.	206
Acetylation of Sulphanilamide in Plants.—Dr. D. Rudd Jones and Jenifer Wignall	207
Rat Liver Xanthine Oxidase in Carbon Tetrachloride Poisoning.—Dr. Gilberto G. Villela and Emilio Mitidieri	208
Infectivity and Nucleic Acid Content of Influenza Virus.—G. L. Ada and Beverley T. Perry	209
Total Sugar and Nitrogen Contents of Jute Plants, with Special Reference to the Flowering Stage.—Miss Sumitra Talukdar	210
Cortical Zonation and Survival of Chromaffin Cells in Adrenal Autografts.—Rex E. Coupland	211
A Substance from Eel Serum producing Slow Contractions.—Dr. R. Jaques	212
Spontaneous Microscopic Activity in Cardiac Muscle.—K. Hellmann	212
Phenolic Substances of Pear–Apple Hybrids.—A. H. Williams	213
Growth of *Chondromyces crocatus* in Pure Culture.—C. W. Hesseltine and Dorothy I. Fennell	213
Shape of Bacterial Flagella.—Prof. Adrianus Pijper.	214
Use of Snail Stomach Cytase in Plant Cytology.—T. C. Chambers	215
Selective Fertilization following the Use of Sperm Mixtures in the Mouse.—R. G. Edwards	215
Role of the Nuclei of the Follicle Cells in the Formation of the Chorion in *Cimex lectularius columbarius* Jen.—B. Dasgupta and H. N. Ray	216
Rearing Experiments on Marine Teleost Larvæ and Evidence of their Need for Sleep.—S. Z. Qasim	217
Population Regulation in Rabbit Nematodes.—P. C. Bull	218
Absorption Spectrum of Deeply Coloured *Cyclo*pentadiene Polymers.—C. F. Blakely and Dr. A. Wassermann	219
Mechanism of Osazone Formation.—Dr. Vincent C. Barry and P. W. D. Mitchell	220
Recent Scientific and Technical Books	Supp. vi

CHAPMAN & HALL

Just Published

INTRODUCTION TO ATOMIC AND NUCLEAR PHYSICS

by

Henry Semat, PH.D.

Third Edition, Revised and Enlarged

9" × 5½" 576 *pages* *Illustrated* 50*s. net*

FUNDAMENTALS OF TRANSISTORS

by

L. M. Krugman, B.S., M.S., P.E.
(U.S. Signal Corps Laboratories)

8½" × 5½" 140 *pages* 110 *figures* 21*s. net*

THE TECHNOLOGY OF SOLVENTS AND PLASTICIZERS

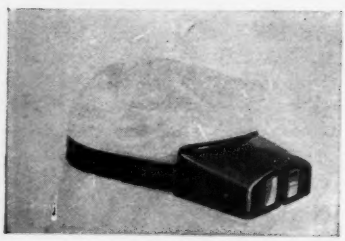
by

Arthur K. Doolittle
(Assistant Director of Research, Carbide & Carbon Chemicals Co., U.S.A.)

9½" × 6" 1056 *pages* 463 *figures* 130 *tables* 148*s. net*

37 ESSEX STREET, LONDON, W.C.2

MAGNIFIERS



The headband magnifier which is illustrated is one of the 200 different types described in our free booklet, "Magnifiers and Visual Aids". Hand reading glasses, watchmakers' eyeglasses, triple achromatic loupes, illuminated stand magnifiers, telescopic spectacles: all are included.

Please ask us to send a copy.

RAYNER
100 NEW BOND STREET, LONDON, W.1
Telephone GRO 5081

Second-hand Books
ON
PURE AND APPLIED SCIENCE

STANDARD WORKS : SETS OF SCIENTIFIC JOURNALS, OLD AND RARE SCIENTIFIC BOOKS

LARGE OR SMALL COLLECTIONS BOUGHT

H. K. LEWIS & Co. Ltd.
LONDON: 136, GOWER STREET, W.C.1
Telephone: EUSton 4282 (7 lines) Established 1844

The SCIENTIFIC BOOK SUPPLY SERVICE
(T. FREDERICK DE LOCHE)

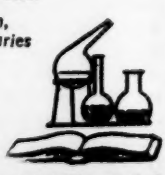
LIBRARIES PURCHASED

Consult us whenever you wish to buy or sell

HIGHEST PRICES PAID

Suppliers to American, Colonial & Foreign Libraries

Specialists in Scientific Books & Periodicals



PHONE: CEN. 1294

5 FETTER LANE, FLEET STREET, LONDON, E.C.4

UNIVERSITY EDUCATION IN CENTRAL AFRICA

TEN years ago, the University of London accepted a special responsibility concerning the development of higher education in the Colonial territories of the British Commonwealth. The aim of the University's action was the fostering of ultimately independent and autonomous Colonial universities, and for this purpose there was formed in 1944 a Committee of the Senate for Higher Education in the Colonies. This Committee—not to be confused with the Inter-University Council for Higher Education in the Colonies—had the task, among others, of considering the applications of Colonial university colleges for acceptance into what came to be known as 'special relationship' with the University of London. The latest applicant for entry into special relationship has been the new multi-racial Rhodesia University College, the origins of which have previously been discussed (*Nature*, **172**, 1; 1953; **173**, 1007; 1954).

In its special relationship with such institutions, the University of London has an interest in almost every aspect of their development, especially in the academic standing of the staff, in the appointment of which it plays an active part. Another important matter is the level which a candidate must reach in order to gain entry to the college. The degrees granted are those of the University of London, and the final decision on syllabuses and examinations rests with that University for so long as the special relationship exists. In some Colonial territories the secondary school system is not sufficiently developed to enable candidates from school to attain the normal standard of entry to the University of London. Since the ultimate standard attained is fixed—that of a bachelor's degree of the University of London—the ordinary course of study in the relevant university college is, in such instances, longer than that laid down by the general regulations of the University of London.

The inaugural board of the Rhodesia University College has recently decided to ask the University of London to make no special concession with regard to the entrance requirements for its College. In the Federation of Central Africa, the Cambridge Overseas School and Higher Certificate examinations are taken in the secondary schools. For admission to the University of London a candidate normally needs to possess a General Certificate of Education with passes in prescribed subjects, of which at least two must be at the Advanced level, but passes in principal subjects of the Cambridge Overseas Higher School Certificate are accepted as equivalent to passes in the General Certificate at Advanced level. The University also accepts credit passes in subjects of the Cambridge Overseas School Certificate as equivalent to ordinary passes in the General Certificate examination. The high level of entrance standard demanded by the Rhodesia University College will keep the number of non-European entrants to a small proportion of the total when the College opens in 1956. But one may hope that with an adequate intake of European students, competition for entry will lead to a rapid expansion in the number of African secondary schools in the Central African Territories which include sixth forms, and a rise in the size of the sixth forms in those schools which already teach at sixth-form level. The muster of teachers suitably equipped to partake in such an expansion may well become a limiting factor, and the availability of school-teachers will itself depend in part upon the flow of graduates from the Rhodesia University College. The conditions to be expected at first are therefore unlikely to lead to the immediate appearance of a large number of non-European graduates in Central Africa. Nevertheless, the importance can scarcely be overrated of the new multi-racial College as a contribution to the higher education of the African at a most significant period in the history of the continent. Those who complete the full course will have reached a high and internationally recognized standard of university education, and the number of Africans who graduate each year will certainly rise early in the College's existence.

According to present plans, the Rhodesia University College will open in 1956 with Faculties of Arts and Science, and a Faculty of Agriculture also may be among the first to be instituted. The Faculty of Arts is expected to include, from the beginning, departments of English, modern languages, Latin, history, economics, African studies, and education. The Faculty of Science will cover mathematics, physics, chemistry, zoology, botany and geography. Later will follow Faculties of Law and Medicine, and still later Engineering, Architecture, Music and Fine Arts. In due course, special relationship with the University of London will cease, and Rhodesia University College will thereupon become a university granting its own degrees.

The financing of a new university is difficult enough in any country; but in a Federation the European inhabitants of which do not exceed a quarter of a million, it is indeed a problem. Of the £2,000,000 which will, according to estimates, be required for capital expenditure during the early years of the University College's existence, £1,250,000 has been promised from the Colonial Development and Welfare Fund and about £300,000 subscribed in the Federated Territories. The recurrent costs are expected to reach not less than £250,000 per annum by 1961, and however generous the endowments may then prove to have been, a significant proportion of the current income will clearly have to be provided by the Federal Government. The growing dependence of universities upon government support is an inescap-

able condition of the development of higher education at the present time.

In a country where racial tension can arise, the position of a multi-racial university is especially important. Some of the difficulties to be faced in such a university are indicated elsewhere in this issue (p. 186) in an article by the Vice-Chancellor of the University of Malaya, an institution which had the advantage of building on two established colleges. The declared aim of the Central African Federation is a partnership between the races, European and non-European; and to the attainment of this ideal a university, with the goodwill of the people and the support of the government, can make a tremendous contribution. The working out of partnership in all its details must depend vitally upon the co-operation of educated people of all kinds. The Moffat Resolutions adopted by the Legislative Council of Northern Rhodesia on July 29, 1954 (*The Times*, August 14, 1954), began the task of defining partnership in a more precise way than has hitherto been attempted: "(1) The objective of policy in Northern Rhodesia must be to remove from each race the fear that the other might dominate for its own racial benefit and to move forward from the present system of racial representation in the territorial legislature towards a franchise with no separate representation for the races. (2) Until that objective can be fully achieved a period of transition will remain during which special arrangements in the Legislative and Executive Councils must continue to be made so as to ensure that no race can use either the preponderance of its numbers or its more advanced stage of development to dominate the other for its own racial benefit. (3) During this period of transition, special legislation must be in force to protect, to the extent that may be necessary, the interests of either race. Meanwhile this Council notes and agrees with the statement of the Secretary of State that it is the duty of Her Majesty's Government to ensure that on contentious issues the balance is fairly held. (4) Every lawful inhabitant of Northern Rhodesia has the right to progress according to his character, qualifications, training, ability and industry, without distinction of race, colour, or creed". The significance of education, and particularly the education of the African, in the working out of such a plan must be clear to all.

The inaugural board of the Rhodesia University College has expressed its deep appreciation of the great educational services rendered by the universities of South Africa to the territories of the Central African Federation over a long period of years. It has also recorded its pleasure at the many messages of goodwill received from South African universities when the foundation stone of the Rhodesia University College was laid by the Queen Mother in July 1953. The inaugural board believes that these tokens of goodwill are a sign of the interest and support of the universities of South Africa which the new College will retain in the future. Universities in Great Britain also will wish to support in their several ways a university institution of such outstanding significance to the future of the British Commonwealth.

MEDICAL BIBLIOGRAPHY AND ITS PROBLEMS

The Development of Medical Bibliography

By Dr. Estelle Brodman. Pp. ix+226+3 plates. (Publication No. 1.) (Baltimore: Medical Library Association, 1954.) 5 dollars.

THE problems of medical bibliography are cognate with those of scientific bibliography in general, and this small book will therefore be of interest to a wider circle than that for which it is primarily intended. The task of the medical bibliographer may be adequately described in the author's phrase: "to cover the entire medical literature, in whatever form, wherever published, and in whatever language, and to cover it accurately, promptly, and in easily usable form". The history of this subject has been dealt with in scattered communications for different periods and subjects; but this work is the first attempt to give a comprehensive history. If the generic subject 'medicine', embracing as it does several undoubted 'sciences', is accepted as a science, then there is probably no subject in the whole range of scientific literature which has been so well served by the bibliographer. The success of his efforts in the past and in the present should therefore be of great interest to all who view with misgiving, and even alarm, the enormous increase in the literary output relating to all the sciences.

Miss Estelle Brodman has wisely limited her field to the subject of medicine in general, and has excluded works dealing only with its subdivisions and specialties. The general medical bibliography deals with these subdivisions, though less thoroughly than the specialized bibliographies of these subjects. Further, the specialized bibliography is a comparatively late arrival in the field. The early bibliographies were all comprehensive works which invited consultation on any subject relating to the art of medicine.

The earliest medical bibliographies were poor things when examined with our present critical knowledge, and such as the historian still consults to-day he tends to find time-consuming and tiring to the eye. Of those published in the sixteenth century, the first was the "De medicinae claris scriptoribus" (1506), by Symphorien Champier, and the first subject-bibliography was that of Israel Spach. Champier's work was printed in black-letter after the style of a late fifteenth-century manuscript. The medical bibliography of Conrad Gesner was never published. In the seventeenth century the custom of listing authors under their surnames instead of under their forenames became very general, the imprint was given regularly for each edition, and the number of cross-references relating to both authors and subjects was greatly increased. The bibliography of J. A. Vander Linden was first published in 1637, and went through two further editions during his lifetime and one (1686) after his death. It is still used by historians; but the work would be more acceptable now if both Vander Linden and G. A. Mercklin, his final editor, had adopted Sir Thomas Bodley's request to the first librarian of the Bodleian: "I did alwaies wishe that in the setting downe of an author's title, you would place his surname first". The "Bibliotheca realis medica" (1679) of Martin Lipenius contained about twice the number of entries in Vander Linden. It was printed on a

quarto page in double column and was, to our eyes, of a much more modern lay-out.

The late eighteenth and the first half of the nineteenth centuries were the age of the great bibliographies compiled by single individuals. Some of these dealt with limited periods and are not discussed by Miss Brodman. Of these may be mentioned Choulant's "Handbuch der Bücherkunde" (1841), which is still of great value. The great bibliographies of this period were undoubtedly those of Albrecht von Haller, of Ploucquet and of Callisen. Haller's bibliography of practical medicine was only one of four similar works which he compiled. It contains fifty-two thousand references to books, dissertations and also to important articles, and it frequently gives brief critical notes on the contents of the works listed. This work by Haller is not of great value to-day, but his "Bibliotheca anatomica" is still a very useful and accurate work. Wilhelm Gottfried Ploucquet was the first bibliographer who had to tackle seriously the problem which is still fundamental—the listing of the journal-article. Between 1793 and 1797 he published eight volumes of his "Initia". The work was then complete—but only to 1793. In the interval new literature had appeared so fast that it required a supplement of four volumes to cover it. Faced then with a further large accumulation of titles, Ploucquet took the bold step of deciding to reprint his twelve volumes in a more complete and convenient format, and to integrate them so as to include their contents and his last accumulation in one alphabet. In this work he had to face the fact that it was no longer possible for one individual to define the contents of all articles listed except from the information given in their titles, and he also realized that important medical observations might be found in works which were not entirely, or even primarily, of a medical character. Callisen's invaluable "Lexicon", published in thirty-three small volumes between 1830 and 1845, is more limited in scope since it deals only with literature published roughly between 1750 and 1830. Ploucquet's work was arranged by subjects, Callisen's by authors' names.

Scientific and medical bibliography now passed into the co-operative stage, the first result being the "Catalogue of Scientific Papers, 1800–1863", which was published by the Royal Society in six volumes in 1867 and the following years. Two new volumes, covering the period 1864–73, appeared fairly soon, but the four additional volumes bringing the work up to 1883 were not published until 1902. For the seventeen years 1884–1900 seven volumes were required, and it took more than ten years to publish them. While the earlier volumes are within the means of the serious historical student, the later volumes are very costly. No supplements have yet been published dealing with the literature since 1900.

An even greater co-operative undertaking is one known to all workers in the medical field, the "Index-Catalogue of the Surgeon-General's Library". There had been five small catalogues of the books in this very rapidly expanding library between 1863 and 1873, when John Shaw Billings conceived the idea of a catalogue which would be arranged by authors and by subjects and which would, in addition, list all the important articles in journals. The first volume was published in 1880 and the sixteenth and final one in 1895. By this time the accumulation of fifteen years, which was to be published in a second series under a new alphabet, had reached such proportions that it took more than twenty years to publish the necessary twenty-one volumes. By 1916, therefore, before the commencement of publication of the third series, all references relating to authors or subjects beginning with the letter *A* were complete only up to the year 1895. From the aspect of current medical and scientific work, the catalogue was generally about twenty years out of date. The third series followed, and then a fourth, which was carried to the first part of letter *M*, when publication stopped with Vol. 10. A final volume is expected soon, but that will probably be the end of this great work.

Of the 178 pages of text in her book, Miss Brodman devotes more than forty to the position at the present day—the varying fortunes of the "Index medicus" and its gradual replacement by the "Quarterly Cumulative Index Medicus"; the rise of the "Current List of Medical Literature" and its merits compared with those of its older contemporary. As her work is essentially a history, it may be argued that it would have been better to have stopped at an earlier period. On the other hand, it is desirable that the ramifications of these difficult problems should be fully understood by all who have to make extensive use of medical books and journals, and this final chapter sets out the facts very impartially.

What are the facts? Long known to all who have viewed the field in historical perspective, they are quite clearly that medical bibliography is not now, and never has been, completely comprehensive and up to date. The early bibliographies were essentially tools for the use of the compilers, and no doubt personal interests sometimes had an effect on their completeness in certain directions. But apart altogether from this factor, there was no chance of a single individual being able to trace all the works published even during a limited period. It has been estimated—admittedly by methods which cannot be very refined—that the number of medical works printed before 1501 was 966, and that between that year and 1636 the number of editions of medical works printed was about twenty-five thousand. In his bibliography, published in 1679, Lipenius lists about 40 per cent of the authors possibly represented by these works. At the end of the eighteenth century Ploucquet was finding that his new material amounted to about ten thousand references a year. Medical and scientific journals were then in their infancy. In 1800 their number was 910. By 1866 it was more than fourteen thousand; by 1901 the number was nearly sixty thousand; and by 1908 more than seventy thousand distinct journals were being published.

Dr. Claudius F. Mayer, the distinguished editor of the "Index-Catalogue", has said that the manuscript cards increase by more than a hundred and twenty thousand yearly. The fifty-seven volumes of the "Index-Catalogue" which have so far been published contain about three and a half million references. Allowing something more than sixty thousand references per volume of the "Index-Catalogue", this means that at least two volumes per year would be required to keep up with the current intake; at its best times only one volume was published per year in the past. The present situation is far from satisfactory, and it may have to be admitted that it is impossible to provide a fairly full bibliography of medicine which is always up to date and which in the same form provides easy reference over a long period. When the "Index-Catalogue" was about to expire, many sincere requests for its continuation

passed from Great Britain to the United States, but other considerations prevailed. Despite its faults, the "Index-Catalogue" does provide a permanent record of most of what is worth while, and it does so in a manner which allows of easy consultation.

Miss Brodman has written a valuable little book, to which is appended a very full list of medical bibliographies since 1500. A few minor errors are unimportant; but there is one strange mistake which should be corrected at the earliest opportunity. The author describes the lay-out of a page of Haller's "Primae lineae physiologiae" which she says appeared in eight volumes. The "Primae lineae" was a very fine one-volume students' text-book which went through many editions and translations. The great eight-volume work for which this name is a *lapsus calami* was his "Elementa physiologiae corporis humani", the eight volumes of which were published between 1757 and 1766, and not in 1747 (the date of the first edition of the shorter work). Miss Brodman perhaps gives the impression that the *Philosophical Transactions of the Royal Society* was a private venture only during the time of Oldenburg. In fact, the journal was the property of the secretaries of the Royal Society until the year after the death of Sloane. Apart from a reference in the appendix, she makes no mention of Pauly's bibliography of 1874. This is not an important omission; but in view of the fact that this work has recently been reproduced in facsimile—some authorities may consider the reproduction was uncalled for—a few notes on its merits might have been useful.

E. Ashworth Underwood

A TECHNOLOGICAL APPROACH TO THE STUDY OF BACTERIAL MORPHOLOGY

La Cellula Batterica

Di Dr. Franco Scanga. Pp. xix+477. (Roma: Il Pensiero Scientifico, 1954.) 8000 lire.

THE recent very considerable advances which have been made in the study of the morphology and cytology of bacteria have been published almost exclusively in English. It is therefore something of a landmark in the history of the subject to find so well-informed a work in any other language; and it says much for the excellence of Dr. F. Scanga's handling of his material, and the clarity of his Italian style, that I was able to read an extensive passage from one of my own works, translated from English, without any feeling of unfamiliarity. This is not always true of paraphrases in the same language by other pens.

The book is in no sense a monographic study, but is rather an attempt to provide a fully documented account of recent work in this field, with an almost exclusive emphasis upon the better-known groups of bacteria. Although the effect has been to make it considerably larger, and thus presumably more expensive, than would otherwise have been necessary to convey the essential information, the language problem dictates that this is much the most valuable, and indeed the only suitable, form for the book to take. For example, Dr. Scanga neither supports nor opposes the claims of the Philadelphia group, but simply states them at length and follows with an equally full quotation from one of their more outspoken critics. The reader is left to form his own opinions.

The illustrations are numerous and well reproduced. Full use has been made of the plates which originally appeared in the Symposium on Bacterial Cytology, held in Rome in 1953, but not always with the happiest results, since many of these were originally provided by the contributors to illustrate particular points rather than general principles. It is especially unfortunate that the caption of Chapman and Hillier's now famous electron micrograph of a section of *Bacillus cereus* gives an interpretation proposed by another person on that occasion, rather than the entirely different, and much more generally acceptable, interpretation of the original authors.

As may be expected in a book of this nature, technical questions are given great prominence, and a wide selection of cytological methods is described in full, with the originators' own opinions in respect of their efficacy stated without comment—a state of affairs which may mislead intending practitioners, in some cases. Dr. Scanga's own special interest is the electron microscope, which he handles with considerable skill; and a valuable account of the techniques accompanying the use of this instrument is included. Electron micrographs accordingly provide a somewhat disproportionate preponderance of the illustrations. It might, in other circumstances, be regarded as slightly curious that the only really clear example of the now classical appearance of the bacterial nucleus, by the Robinow–Piekarski technique, is included in a page of electron micrographs, in order to establish that the much less instructive protuberances, visible upon these desiccated surfaces, actually represent the nucleus.

But these are minor blemishes in an otherwise excellent work. The author has taken the trouble to acquaint himself with the massive body of evidence which has become available, at least within the limits which he has set himself, and shows every sign of understanding it thoroughly. This is especially refreshing in a field where many who have started out with similar high intentions have retired before long behind a smoke-screen of obscurantism.

K. A. Bisset

COLOUR PHOTOGRAPHY

Principles of Colour Photography

By Ralph M. Evans, W. T. Hanson, Jr., and W. Lyle Brewer. Pp. xi+709. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 88*s*. net.

SOME readers of this authoritative book are likely to be disappointed unless they appreciate that it is the principles of colour photography which form its subject-matter and not colour photography itself. Only one chapter of forty-one pages out of a total of more than seven hundred is devoted to a description of the various colour photographic processes and cameras, and no colour prints are included anywhere in the book. Readers must therefore go elsewhere for a colourful presentation of the subject; but they need be under no illusion as to the ability of the authors to practise the art about which they write, for one of them, R. M. Evans, is perhaps the outstanding exponent at the present time of the artistic possibilities of colour photography.

The theory behind colour reproduction, whether by photography or television, has become quite

highly developed, and the starting point is usually the laws of three-colour mixture. In terms of colorimetry, the reproduction should consist of the appropriate combination of red, green and blue radiations that will, at each point of the picture, match the colour of the original at that point. This provides a working hypothesis from which to derive such items as the theoretical spectral sensitivities of the three light-sensitive processes in the colour camera. For various reasons, major departures from colorimetric theory are both necessary and inevitable, and it is no easy matter to present a comprehensive and comprehensible account of all the factors that ultimately have to be considered. This, however, is in essence the main intention of the book under review and the authors have made a notable and successful contribution in this field.

First, we have chapters dealing with colour matching and colour measurement (those interested in the algebraic representation of these matters will be surprised to find colour equations given in a form which has been generally condemned in the United States although common practice in Great Britain until recently), followed by a discussion of the visual processes of adaptation, contrast and the like, which affect so vitally the subjective appearance of a picture yet are so baffling to express in algebraic or numerical terms. Next, we have chapters on the chemistry of the photographic processes and the optical characteristics of dye mixtures and their measurement, leading naturally to colour sensitometry and the consideration of the *H* and *D* characteristics of colour processes. Two chapters dealing with the special cases of duplicating and copying are interpolated, and the final two chapters discuss the generalized theories of additive and subtractive reproduction.

It will be realized that this book is full of weighty material which cannot be described as light reading, yet the text itself is written in a very clear style and is therefore easy to read. The authors are well aware that they have not written the final word on the subject, for their closing paragraphs and indeed the closing sentence emphasize that lack of knowledge of the visual relationship between the photograph and the scene makes it necessary for present-day processes to be worked out empirically. Yet this is an excellent statement of our present understanding of the problem, and no serious workers in colour photography or colour television can afford to ignore it if they wish to reduce the empiricism in their techniques to a minimum.

W. D. WRIGHT

PRESENTING MODERN CHEMISTRY

General Chemistry

An Introduction to Descriptive Chemistry and Modern Chemical Theory. By Prof. Linus Pauling. Second edition. Pp. xii+710+2 plates. (San Francisco: W. H. Freeman and Company, 1953.) 6 dollars; 51*s*.

WHEN, at a conference in the United States, Prof. Linus Pauling was asked about his views on the teaching of chemistry he is reported to have said: "One wants to teach that section which inspires and holds a man and which feels alive; then, moving on to greater and greater triumphs, that which both fascinates and profits mankind. The text-book should contain what the writer really believes and really knows, not the stuff which seems dead and ought to be put into museums". The speech reveals the attitude to teaching in which "General Chemistry" was written and the principles which guided the writer in selecting his material and arranging its sequence. "That which inspires and holds a man . . .": the speaker, the grand-master in the field of the ionic bond and of the electronic structure of the molecule, showed in this work how a simple exposition of modern theoretical concepts could, to use his own words, make the presentation of general chemistry "more simple, straightforward and logical than formerly". All who have used modern theory in their teaching will concur. "General Chemistry" rapidly obtained world-wide recognition as belonging to that small class of books, as did the works of W. Ostwald and of Alexander Smith in days gone by, which revolutionized the teaching practice then prevailing and laid down the pattern for future texts.

The first edition was reviewed and commended in *Nature* (June 26, 1948): its contents are too well known to be again listed; but those yet unacquainted with "General Chemistry" should know that it is an introduction for first-year university students. In this, the second edition, Prof. Pauling gives us further teaching help, for he shows us how he meets the difficult problem of giving an adequate presentation of a science, which, already huge, is expanding in every direction. His plan is to increase the depth of the treatment of theory, especially of those aspects which are pertinent to the explanation of chemical behaviour and which are integrating in their incidence, so that all but the future specialist will have sufficient theory to carry him through his entire chemistry course. At the same time, a new chapter entitled "Biochemistry" extends the breadth of treatment and introduces a humanizing factor. For this chapter is essentially a fascinating essay on proteins, vitamins, drugs and their relation to life and mankind.

Most of the additional theory is in two new chapters, respectively entitled "The Electron and the Nucleus", and "Quantum Theory and Molecular Structure". Among the topics discussed in these chapters are: X-rays, the electron, radioactivity, the atomic nucleus, the quantum theory, the photoelectric effect, the photon, and the changed outlook brought about by quantum mechanics.

The new introductory chapter on metals is not only interesting and inspiring but also illustrates the author's ability to use the electronic theory to explain and systematize the phenomena under discussion. Thus he shows how the increase in the structural strength of successive metals in a Mendeléeff period is dependent upon the electronic configuration of the metal and of the arrangement of its atoms in the crystal. Physical properties are therefore no longer seen as haphazard phenomena but, as with chemical properties, are determined by structure, and are predictable.

The four new chapters, and the revision and frequent extensions of most of the original chapters, enlarge the book by 115 pages. The flashes of understanding which must come from a study of "General Chemistry" and the freshness of approach to the subject-matter make it an excellent text for first-year university students or for candidates for university scholarships. If not used as a text-book, a copy should be in every chemical library.

G. FOWLES

THE UNIVERSITY OF MALAYA

By Sir SYDNEY CAINE, K.C.M.G.
Vice-Chancellor

THE University of Malaya is now five years old. What are its achievements, its opportunities and its problems? Created by the amalgamation of two Singapore institutions, the King Edward VII College of Medicine and Raffles College (covering arts and science), its first tasks were to merge these two units and secure recognition of their standards; to extend the range of teaching; to get assured finance for maintenance and growth; and to create an adequate physical centre for itself.

During all its early years the University has been troubled—some would say bedevilled—by the last problem, of siting. It had been agreed by the Governments of Singapore and the Federation of Malaya that the University should be moved out of Singapore to a site some twenty miles away in Federation territory, across the Strait of Johore. This project had many attractions, especially politically; but as time passed it became very clear that such a move would meet many obstacles, would cost vast sums of money and would take many years. Doubts accumulated of the inherent wisdom of removing from close contact with the life and culture of the leading city of Malaya. Growth in numbers—much more rapid than had been expected—produced pressing demands for more facilities now on the Singapore site rather than alternative facilities years hence elsewhere; but action was paralysed by the prospect of ultimate removal.

The financial position was equally inimical to long-term planning. The two Governments had met without demur the annual demands of the University as presented but had made no specific promises for the future as to either recurrent or capital expenses, leaving the academic staff in doubt whether money would always be forthcoming so readily and so unconditionally.

During the past year both site and finance have been publicly discussed and reviewed by the University and the Governments. Three main conclusions have been unanimously accepted: the project of removal to Johore is abandoned; the University will retain its home in Singapore where it has considerable space for development, but will also, with growth in student numbers and in technical studies in mind, begin a second university centre at Kuala Lumpur, the Federation capital; and finance is assured by a promise of annual Government grants over a five-year period on an escalator basis, plus a minimum capital grant. The money promised is less than the University asked for; but the minimum annual grant is to rise from £640,000 for 1954–55 (against £560,000 in 1953–54) to £780,000 in 1958–59. For capital the University will be largely dependent on further assistance from the Colonial Development and Welfare Fund (from which £1,000,000 is already promised) and from private benefactions. These decisions give a firm basis for further progress, and urgently needed new buildings will be started almost at once.

What, on the other side, is the academic basis for progress? The existing faculties are in arts (including English, oriental studies, geography, history, economics, education and mathematics), science and medicine, making a total of twenty-seven departments. Staff has expanded from the 60 taken over from the Colleges to 140 at the beginning of the 1954–55 session. Student numbers have grown in five years from 450 to 1,050. New departments added since 1948 include education, Malay studies, Chinese language and literature, philosophy, social medicine, parasitology and orthopædic surgery. Social studies, in which a diploma is awarded, has been added as a sub-department of economics, and independent lectureships have been established in the history of art and in child health. Although additional buildings are needed, the University is already fortunate in having good and well-equipped laboratories, a large and progressive teaching hospital and substantial general accommodation. By a wise decision, the one important building put up since 1949 has been a well-equipped library which houses a good collection of English books and one of the largest collections of Chinese books in Asia outside China itself.

In maintaining degree standards, the University relies very much on the distinguished scholars from the United Kingdom and elsewhere who act as external examiners and pay regular visits. Its M.B., B.S., like the medical diploma of the former College, is a registrable qualification in the United Kingdom and, more significantly for the reputation of the Medical School, the Malayan diploma in public health begun last year was at once recognized by the General Medical Council. No equally clear-cut 'recognition' is available for non-medical degrees; but students with a University of Malaya honours degree are accepted for higher studies at leading universities and professional institutions elsewhere.

Academic standing is judged not only by the first degrees awarded but also by the output of research. Here, after five years, it is fair to look at the promise rather than the achievement. Recognizing the importance of research, the University immediately provided for a full range of higher degrees. To date it has awarded seventeen M.A.s or M.Sc.s, three Ph.D.s and five M.D.s. At the commencement of the 1954–55 session, twenty-seven students were registered for higher degrees. Much research work is also being pursued by senior members of the staff without formal registration, and there is a steady flow of papers published in learned journals. A research unit for social research has been set up, and several research students have been attached under Fulbright arrangements.

The University is thus a functioning mechanism, sending a regular stream of graduates into the professions and public services of Malaya—some 70 doctors and dentists a year and 120 non-medical graduates; and prosecuting specific research in all its main branches of study. What are its opportunities?

First are its teaching opportunities. Malaya is progressing steadily towards self-government; the senior Government services, the professions and local business managements will soon be recruiting scarcely any but local men and women. They need not all be locally educated; but the University of Malaya ought certainly to provide a high percentage of the university-trained personnel of the Malaya of the

future. To do that it must broaden the scope of its teaching. It must add departments or faculties in engineering, agriculture, law and the complex group of social studies which includes government and political science, applied economics and social anthropology. A start is to be made on all these within the next quinquennium, besides developing existing departments.

Such a widening of scope is not too ambitious if full university stature is to be attained, and there is adequate reason to expect a flow of students sufficient to fill these courses and, incidentally, to justify the beginning of university teaching in Kuala Lumpur. There are to-day more Malayan young men and women studying at university-level outside the country than there are at the University of Malaya; most of them are studying subjects not yet taught in Malaya, and a good proportion would no doubt have come to Singapore if these subjects had been offered there. Furthermore, a very rapid expansion in secondary education is taking place in Malaya. Even allowing for some brake on expansion at the higher levels imposed by shortage of teachers capable of maintaining the necessary standards, the numbers seeking a university education look like doubling in the next decade.

Relevant to the question of numbers is the fact that the University to-day draws very little upon the 'Chinese' schools, which provide a self-contained system of primary and secondary education distinct from the 'English' schools and relying mainly on Chinese as a medium of instruction and on Chinese inspiration in general subjects. Pupils from such schools qualified for a university education formerly went to China for it. There is now a project to create for them a separate institution, to be called the Nanyang University, although they are only a fraction of those from the English schools and could scarcely support a separate university of Western academic standards. It is important that they should not be denied entry to the University of Malaya, and means are now being examined by which the language difficulty can be surmounted and a regular channel of entry from these schools established.

A university is not, however, just a machine for turning out highly trained professional men. Equally important are the spirit, the philosophy and the culture they carry with them. Here the prospective political and social development of the country makes the role of the university even more vital. Maintaining the values of life as we see them in the West, and the standards of political and public life, will make great calls on the young men and women who will be filling the public services, the law and other professions in the next five or ten years. In living up to its responsibilities in this field, the University has to steer a delicate course in the teaching, encouragement or toleration of political thought and discussion; still more delicate are the susceptibilities in the religious field when students are drawn from so many faiths—Moslem, Confucian, Hindu, Buddhist and Christian. In so far as political, philosophical or religious ideas are taught, they tend to become vague distillations of the essential truths of many creeds and to lack sharpness and punch. The widely realized problem of how to instil some real philosophy of life in a secular university is particularly difficult in a country of such varied make-up and in which almost all identifiably Western doctrines except Communism are liable to be suspected of a 'Colonial' taint. None the less, difficult as the task is, the handing on of the essence of Western culture is one of the greatest of the opportunities of the University of Malaya.

So much for what can be taught. What of the things to be learned, the research opportunities? In natural science special opportunities arise from the physical situation of Malaya. Singapore is barely 1° from the Equator. In physics, although claiming no special facilities for pursuing the main lines of current physical research, Singapore is uniquely situated for the study of equatorial meteorology; Malaya can also offer its own special contribution in rock magnetism. Probably no other university offers as good facilities for the study of equatorial marine fauna. In botany there is the basic study of the behaviour of plants in a virtually seasonless climate, as well as much scope for further systematic work on the rich equatorial flora; and chemistry can, *inter alia*, supplement the work of the botanist with systematic study of the properties of that flora.

The geographical situation also opens opportunities of special research in the medical field. The distinguished tradition of research in Malaya is still carried on in the Institute for Medical Research at Kuala Lumpur, and is now being supplemented by work in the University. Among many special topics attention is being paid to parasitology, local virus diseases and to physiological reactions to the heat conditions of the equatorial tropics.

In human or sociological studies, special opportunities arise less from the equatorial situation than from history and economics. South-east Asia has always been a meeting-place of cultures, and the ordinary complications of mixed societies are given a special flavour in Malaya by the fact that the diverse races are mixed in such proportions that each one is, statistically speaking, a 'minority'. The very newness of the country—by the standard of the date of effective opening-up to close human settlement most of it is newer than the United States—makes its sociology a living study of pioneering and of the absorption of mass immigration. In economics, Malaya provides an outstanding case of the 'export economy' and of dependence on highly fluctuating world markets, and much of the special reaction on the local economy has still been only superficially studied. As background to all this, more complete study of the history and geography of both Malaya itself and the surrounding countries is being systematically tackled by enthusiastic teams in the respective University departments. In all fields the geographical situation and communication facilities of Singapore justify hopes of its becoming a major centre for the study of South-east Asia as a whole.

A third field of opportunity for the University lies in extra-mural work in a much wider sense than usual, implying not merely (indeed scarcely at all) formal teaching outside the University's walls but also encouraging, stimulating and assisting whatever local initiatives develop in the fields of art, music, literature and general study. Already the University is establishing itself in this way as one of the centres where the public may hear good music, watch plays or look at exhibitions of visual art, and as the headquarters or inspiration of national societies such as the Malayan Historical, Science or Mathematical Societies.

Lastly, what are the problems of such a university? One major problem already mentioned—how to influence the souls and the philosophical beliefs of its students as well as their minds and their technical

knowledge—is bound up with the way the students live. To-day the University of Singapore is more like a British civic university than one of the ancient universities; true, a high proportion live in university residences, but those residences are properly called hostels rather than colleges and have scarcely any of the collegiate atmosphere. The development of that depends on physical facts and will necessitate extensive new building. A second problem is the recruitment of staff. Naturally it is the aim to recruit locally as much as possible, and more than 40 per cent of the staff (including five heads of departments) are Asian; but extensive reliance will be placed for many years on outside recruitment. To-day the non-locals are themselves a very mixed group, countries of origin including, besides the United Kingdom, every other nation in the Commonwealth, Ireland, the United States, Denmark, Sweden, the Netherlands, Switzerland, Germany, Austria, Czechoslovakia, China, Indonesia and Thailand. This diversity of origin broadens the University's scope, but adds to the problems of spiritual unity. The determination to attract staff of the right quality is shown by the very high salaries and allowances offered (for example, assistant lecturers starting at £1,490 per annum actual emoluments and lecturers ranging from £1,638 to £2,688).

Recruitment is linked with a third general problem —the danger of isolation. The fear of being cut off from the intellectual stream of the big universities undoubtedly deters many potential recruits and is a danger in the wider sense to a university the nearest Commonwealth neighbours of which, Hong Kong, Ceylon and Western Australia, are all more than 1,500 miles away. The University reduces the isolation by generous vacation and study leave, by the external examiner system and by seizing every opportunity of attracting distinguished visitors, who can often be caught in Singapore almost literally on the wing as they fly through *en route* to Australia or the Far East. None the less, the maintenance of contacts with Commonwealth, American and European universities is a constant problem, in the solution of which every possible outside help and sympathy are needed. The recent institution of scholarships for the children of United Kingdom staff of Colonial universities by Birmingham is an example of the sympathetic interest required.

Space does not permit of discussing here more localized problems—the administrative complexities of development in Kuala Lumpur as well as Singapore, the linguistic problem of teaching in English to students of diverse mother-tongues, the problems of school educational standards, etc.—but something must be said about costs. All the growing Colonial universities cost a good deal more per student than the average United Kingdom or Commonwealth university. Apart from the inevitable burden of overheads in small institutions, salaries have to be much higher to attract staff, passage and leave grants are expensive and the expenses of external examiners add further to the cost. It must sometimes seem, therefore, as if it would be no more expensive to maintain all the students overseas at older universities. That would be an exaggeration; but in any event this must be regarded as an initial phase of costliness which will pass as more local talent becomes available. The high current costs of operation are properly regarded as part of the capital costs of building up institutions which, in Malaya and elsewhere in the Colonial Empire, represent one of the greatest, if one of the latest, of the contributions of Western influence to the full growth and development of these territories. No better use can be found for further United Kingdom assistance to Colonial development and welfare than a continuance of the generous grants which have made possible the initiation of these overseas university institutions.

RECENT TRENDS OF GLACIER FLUCTUATIONS IN THE NORTH ATLANTIC AREA

A LARGE and varied audience attended a discussion on "Recent Trends of Glacier Fluctuations in the North Atlantic Area" held by the British Glaciological Society in the Department of Geology, Oxford, on November 19. This was the first meeting of the Society to be held in Oxford for some years, and it was opened by Mr. G. Seligman, president of the Society. The main part of the meeting took the form of five short papers given by Mr. C. W. M. Swithinbank (Pembroke College, Oxford), Dr. C. A. M. King (Department of Geography, Nottingham), Dr. M. M. Sweeting (St. Hugh's College, Oxford), Mr. M. F. W. Holland (St. Peter's Hall, Oxford), and Mr. H. Lister (Department of Geography, Cambridge). These papers were mainly concerned with the results derived from recent field-studies on glacier regime and fluctuations in areas around the North Atlantic, particular attention being paid to fluctuations during the past fifteen to twenty years. Prof. Gordon Manley (Bedford College, London) attempted the difficult task of summing up the very diverse contributions and of assessing the extent of the dependence of glacial variations upon present climatic developments. Dr. K. Sandford (Department of Geology, Oxford) was in the chair.

In the first paper, Mr. Swithinbank reviewed the latest work in Scandinavia, where practically every glacier has been in retreat for more than half a century. The rate of retreat increased during the 1930's and caused the disappearance of several small glaciers. The changes of the past ten to fifteen years did not, so far as can be seen at present, reflect either a significant increase or decrease in the prevailing high rate of retreat. We are hampered in a study of recent trends by the small number and indifferent quality of available measurements. A change in the 'state of health' of a glacier is best defined in terms of changing total ice volume and changing material balance. Accumulation and ablation measurements have been made since 1945 on one glacier in western Norway (Storbreen, Jotunheimen), and one in Swedish Lapland (Storglaciären, Kebnekajse)[1]. The marginal retreat of these two glaciers has not, however, been proportional in single years to the net deficit of their regime. Mr. Swithinbank was therefore distrustful of measurements which referred only to the snout recession of Scandinavian glaciers.

Though most glaciers show a time-lag of several years in their response to climatic change, and some appear to follow a rhythmical advance and retreat that is largely independent of short-period fluctuations, there is in Norway a fairly good correlation between the trend of annual mean air temperatures and the mean rate of recession of the glaciers. While

the present glacier trend in western Norway is mainly due to a steady increase in the length of the ablation season, in Swedish Lapland it is apparently caused by rising summer temperatures, which have led to greater rates of melting during the mid-summer months. In west, though not in north, Norway there has been also a steadily decreasing winter accumulation. This is noteworthy, as it contrasts with a more general trend of increasing precipitation recorded at most of the low-lying meteorological stations in the country.

Mr. Swithinbank thought that conclusions of great interest are to be expected in a few years time, when we shall be able to compare running means of the yearly volume changes of a number of glaciers with running mean figures of the climatic elements obtained from observations on the glaciers themselves, rather than at places (like most existing stations) which differ from the glacier-covered areas both in altitude and exposure.

The subsequent papers dealt with details of glacier fluctuations based on field-studies made in the past few years. Dr. King discussed the fluctuations of four glaciers draining south from the ice-cap of Vatnajökull in Iceland. She said that the evidence included measurements of the glacier snouts carried out since 1932 and also evidence of thinning and retreat from field observations made in 1953 and 1954. The following figures give the long-term and more recent trends:

Glacier	1932–53	1951–53
E. Skeidararjökull	− 460 m.	− 34 m.
Morsarjökull	− 557 m.	− 33 m.
N. Skaptafellsjökull	− 800 m.	+ 24 m.
S. Skaptafellsjökull		− 8 m.
N. Svinafellsjökull	− 540 m.	+ 14·5 m.
S. Svinafellsjökull	− 136 m.	+ 13·5 m.

These figures show that on Skaptafellsjökull and Svinafellsjökull the retreat is slowing down or reversing, while the other two glaciers continue their rapid retreat. S. Svinafellsjökull has scarcely retreated at all during the past ten years. These observations may be accounted for by the variations in height of the accumulation areas of the glaciers concerned, as shown by the following figures:

Glacier	Accumulation area (per cent): above 1,400 m.	above 1,700 m.
Morsarjökull	0	0
Skaptafellsjökull	22	8
Svinafellsjökull	51	22

The evidence of thinning of the glaciers indicates a very substantial loss of volume. Morsarjökull has thinned by 90 m. since 1904; during this period two of its three tributaries have become disconnected. Skeidararjökull during the same period has thinned about 76 m. on the evidence of a well-marked trim line. Skaptafellsjökull and Svinafellsjökull were joined at their snouts until the rapid retreat caused their separation in 1935. Since this time Skaptafellsjökull has retreated and thinned rapidly, but Svinafellsjökull, particularly at its south end, has stagnated. The glacier has, however, thinned by 60 m. recently, as indicated by a very pronounced trim line at this height.

The variability of accumulation is marked, which causes considerable variations in glacier budget and fluctuations from glacier to glacier and from year to year. Dr. King concluded that the evidence indicated in general a rapid retreat and thinning of the outlet glaciers of S.W. Vatnajökull, with some exceptions. Those glaciers with the highest accumulation areas are advancing slightly at present.

Dr. Sweeting gave evidence for recent glacier fluctuations in Spitsbergen, where the glacial recession has been very rapid since 1890. She discussed details recorded by Miss G. E. Groom and herself in 1953 of the state of the glaciers in Bünsow Land, central Vestspitsbergen. In this area the disintegration and thinning of the plateau glaciers have continued, apparently unabated, in the past twenty years. Many small glaciers mapped by the Cambridge Spitsbergen Expedition in 1938 have now disappeared. All the glaciers examined in Bünsow Land in 1953 showed signs of marked recession. Great heaps of moraine now remain in front of gently sloping glacier snouts; in many places the ice is stagnating at its terminal ends. Dr. Sweeting quoted as an example, in Bjönadalen, in south-east Bünsow Land, a simple confluence system of two glaciers, the long confluent snout of which has become stagnant; this stagnant ice-mass is in process of being severed from its feed glaciers and is becoming a dead-ice patch. Dead-ice accumulations were mapped in other valleys in Bünsow Land where the glaciers have retreated to leave only a much attenuated snout in the valley head. Some of the steeply inclined cirque-like glaciers have also become detached from their supply areas and are now dead ice.

The behaviour of the major ice fronts in Bünsow Land has been studied since before 1900. The ice front, still largely afloat, of the Nordenskjöld glacier has been mapped by a series of Cambridge expeditions since 1938. Between 1938 and 1953 it showed a continuation of the retreat which was so marked a feature of the 1920's and early 1930's; during 1938–49 the retreat averaged 6–15 ft. a year[2].

No detailed observations on accumulation and ablation have yet been made in this part of Spitsbergen; but the rate of ablation in 1953 was undoubtedly high. In the last weeks of July and the first weeks of August, during the height of the ablation season, the rate of ablation at 500 m. was approximately 29 mm. per day.

Glacier recession has been less marked in North East Land, an island lying to the north-east of the main island of Vestspitsbergen, which is both much more ice-covered and more 'polar' in character. Mr. Holland said that recent observations in North East Land tended to confirm the view held by Glen that the ice is in a generally passive state and that it has a negative regime. In the southern part of the island there is evidence of wastage of the ice in the presence of high heaps of glacio-fluvial debris and in the tendency for small glaciers to become detached from the main ice-caps. The outpouring into the sea of the large ice lobe of Bråsvellbreen from the ice cap of Sörfonna in about 1937 was a spectacular example of the advance of a glacier which probably bore no relation to the present glacial balance and was not an indication of increasing glaciation[3]. Mr. Holland discussed the possible causes for this advance.

The problems concerning glacier fluctuations and regime clearly become more difficult the larger the ice-mass; we have also very little information about the world's large ice-caps. These points were stressed by Mr. Lister, recently back from the British North Greenland Expedition. Conclusions drawn from a study of the advances and retreats of the glaciers associated with the Greenland ice-cap are likely to be misleading,

and the fluctuations of the glaciers in Queen Louise Land do not throw much light upon the glacial balance of the area. However, the existence in Queen Louise Land of a well-marked trim line suggests that thinning of the ice there has occurred. Preliminary results also suggest that in this part of North Greenland ablation at present exceeds accumulation and that there is a negative balance. The recession of the glaciers up the fjords is fairly well established; thinning is not so marked but a new nunatak had appeared[4]. There has been a general decline in the accumulation of inland ice, but recent years have shown a slight increase.

It has been said that the "intensity of glacial recession and shrinkage in recent decades round the northernmost Atlantic constitutes perhaps the clearest indication, among many, of a climatic fluctuation in this region"[5]. The rise of temperature in the northern hemisphere has reached its maximum value in Vestspitsbergen, where the shipping season has lengthened from three months at the beginning of the century to about seven months in the 1940's[6]. Investigations into the causes of glacier fluctuations are therefore of more than glaciological interest. It was along these lines that Prof. Manley summed up the evidence of the five principal speakers. With regard to Mr. Swithinbank's remarks, he agreed that each glacier must be treated on its own merits. Yet if the aggregate effect on the movement of the firn-line, for example, is taken over a decade and for, say, a score of glaciers, as in Iceland or Switzerland, the evidence for temperature trend is undeniable; further, it is supported by actual instrumental data. To Prof. Manley, the fundamental factor linking these varied field investigations around the North Atlantic is that of climate and especially the mean summer temperature. He showed the extent of the correspondence between the fluctuations of glaciers and the overall variations since 1700 of the accumulated summer temperatures on British uplands[7]. It was also noteworthy that the accumulated temperatures of the summer months, corresponding with the ablation season on glaciers, varied in much the same way in eastern North America.

Other problems of glaciological research, Prof. Manley pointed out, had also been raised. At what stage did a snow-bed become a glacier? The small remnants of ice that had been shown in the heads of steep gullies in Spitsbergen begged the question of why cirques had not developed in that area. Field-investigation of glacier behaviour is strenuous and it is necessary to accumulate and integrate results before conclusions can be reached. Glacier fluctuation in Spitsbergen, and probably also in North-East Greenland, is closely connected with the behaviour of the ocean waters and the extent to which sea ice is formed. Ultimately, it will require the collective efforts of many sciences to solve the major riddle, that of ice ages, but field-work will provide the foundation. The field-study of glaciers, like all other field-studies, opens up a variety of further problems for others to discuss.

Speakers in the later part of the discussion were much exercised with the causal connexion between the recent glacial fluctuations and the present climatic developments. Prof. H. W. Ahlmann has already pointed out that the present climatic improvement probably culminated during the 1930's and 1940's, and that in North America the decade 1941–50 was characterized by somewhat lower temperatures and increased precipitation compared with the decade 1931–40[6]. The most important factor so far in causing the recession of the glaciers in areas around the north Atlantic has almost certainly been the greatly increased ablation. But as Prof. Manley pointed out, a series of wet cool summers like the one we have had in 1954 might well alter the ratio of accumulation to ablation and cause a reversal of the present trend of glacier fluctuations; hence, climatic developments of the near future are of particular significance.

M. M. Sweeting

[1] Ahlmann, H. W'son, *Geog. Ann.*, **33**, 90 (1951).
[2] Harland, W. B., *Geog. J.*, **118**, 309 (1952).
[3] Glen, A. R., *Geog. Ann.*, **21**, 1 (1939).
[4] Koch, I. P., and Wegener, A., *Meddelelser om Grönland*, 46, 31 (1912).
[5] Ahlmann, H. W'son, "Glaciological Research on the North Atlantic Coasts", Roy. Geog. Soc. Research Series, No. 1 (1948).
[6] Ahlmann, H. W'son, *Amer. Geog. Soc., N.Y.* (1953).
[7] Manley, G., *Toronto Proc., Roy. Met. Soc.*, 199 (1954).

BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

ANNUAL GENERAL MEETING

THE thirty-fifth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute on Thursday, December 9; the chairman of the Association, Mr. N. G. McCulloch, presided. In his address he referred to the importance of the long and valuable experience acquired by the Institute over thirty-five years, but he also pointed to the need for periodic reviews of policy in order that the Association should continue to pursue the correct objectives. He was particularly concerned with the problems of developing research results and the financing of such development, and with the continued need for close liaison between Institute and mill, in which he thought the trade associations can play a considerable part. The honorary treasurer of the Association, Mr. J. Lindley, reviewed the statement of accounts for the year, and reported that the introduction of the statutory levy has resulted in a considerable increase in the stability of the Association's finances. He warned members, however, that, particularly as a result of continuing inflation, but also because of the increasing demands being made by members, increased expenditure in the future was unavoidable.

Dr. F. C. Toy, director of research, presented his annual report, and described the previous year as one of great activity in which the maximum efforts of the staff had been required to meet the demands made upon them by members. He made particular reference to the newly joined doubling and condenser spinning members, for whom new programmes of work had been begun. Dr. Toy referred to the increasing popularity of the 'Shirley' automatic size box (referred to by one member as "the greatest advance ever made in sizing technique"), and directed attention to a natural development from the size box—the new cold-slurry sizing process. Another programme of work in its early stages was specially mentioned, namely, a fundamental study of the problems concerned with blending fibres, particularly man-made fibres, with cotton and with each other. Dr. Toy pointed out that the Institute now has a staff of four hundred and fifty, and he felt sure that the future is full of promise.

The Institute's laboratories were open for inspection for two full days, when the whole of the staff was

available for consultation, and thirty special exhibits had been prepared. For spinners, three practical results of the work of the Spinning Department were on view: a new type of delivery box for use in the pneumatic conveyance of cotton, a guide for controlling the arrangement of yarns in manifold threads, and the first part of a miniature spinning plant for use in the mill. For the more scientifically-minded, apparatus was shown which had been designed for the study of factors affecting yarn behaviour during ring-spinning. This physical examination is a complicated one, demanding simultaneous measurement of such factors as balloon shape, yarn tensions and ring friction.

In the Weaving Department sizing was in progress, using the automatic size box fed with cold starch slurries. The use of these slurries is only possible because of the control exercised by the automatic size box, which compensates for viscosity changes that occur as the cold slurry is gelatinized; there is considerable saving in the boiling time required and in the ease of handling the size. The samples of cloth woven from slurry-sized warps were shown to be quite satisfactory. Another exhibit concerned with sizing illustrated the work which is directed towards elucidating the difficulties arising in removing starch, during finishing, from fabrics woven from spun viscose. This work is fundamental and involves studying the effect of the rate of drying on the solubility of size films, and is related to studies of the molecular structure resulting from different drying histories. An exhibit in another department of the Institute showed the results of investigations of several new sizes, which had been examined from the point of view of ease of removal in finishing. In the Weaving Shed there was a demonstration of a pneumatic device designed at the Institute to prevent the defect of 'lashing-in'. This defect arises on certain multi-shuttle looms, when weft running from the fabric to a temporarily inoperative shuttle in the shuttle box is carried into the fabric by the operative shuttle.

In the Finishing Department, considerable interest was aroused by a new experimental raising machine, designed at the Institute to study fundamentally the process of raising, and initially the different types of drive to the raising rollers and their power requirements. Much work has been done in this Department on measuring the areas of contact between mangle and calender bowls, and two simple methods were shown which have been specially designed for works use. The bowl deflexion indicator, for example, measures the deflexion of bowls under load and indicates the amount of camber required to correct for this, and to give regular mangling or calendering along the length of the bowl. Of particular interest to chemists were the results shown of an investigation on the minimum requirements of sodium hydroxide and sodium hydrosulphite for a number of vat dyes in the pad steam-dyeing process.

The Rayon Department at the Institute is concerned with all fibres (other than cotton) which can be processed on cotton-type machinery, including viscose and cellulose acetate, and also nylon, 'Terylene' and other synthetic fibres. An interesting exhibit was that of work which has proceeded for some years on the effect of molecular weight and molecular arrangement on the tensile properties of cellulose acetate monofilaments. Also in the Rayon Department was a demonstration of methods of analysing fibre blends. The development of these techniques was a necessary part of the fibre-blending programme referred to in his address by Dr. Toy. Crease-resistant rayon fabrics are now produced in large quantities, and an attempt is being made to relate the mechanical performance of these fabrics to the physical properties of the fibres and the chemistry of the various processes involved.

The Silk Department at the Institute serves a group of members who, before the War, were concerned almost solely with this fibre. These members have more recently become increasingly interested in modern synthetic fibres, nylon and 'Terylene' in particular. There was a demonstration of an experimental machine designed to investigate the hot-stretching of nylon and 'Terylene'. The Department has done much pioneer fundamental work on the chemical constitution of silk fibroin and sericin, particularly by chromatographic and X-ray analysis, and there was a demonstration of how the chemical constitution of different silk fibroins affects some of their textile properties.

An exhibit of particular importance, and one which aroused great interest, was of thirty-five instruments devised at the Shirley Institute for development work, and particularly for quality control in the mill. Many of these instruments are now manufactured for and sold by Shirley Developments, Ltd., the commercial subsidiary of the Association, recently set up to exploit its inventions. Prototypes of such instruments, and, indeed, all new equipment, large or small, are made in the Institute's Engineering Department, which comprises drawing office and combined engineering and instrument workshop. Examples of the productions of this Department were shown in the shop, including an experimental suction drier for the Finishing Department, and parts of the miniature spinning plant for mill use, mentioned above.

The Institute's work on the elimination of problems in the mill due to static electricity is complete for the time, and there was a display of the various devices which have been produced. This work on the elimination of static has, however, stimulated a more fundamental programme on the mechanism of static production, which physicists were able to discuss with the members of the staff concerned. This work may well be closely connected with the difficult problem of reducing the tendency of textiles to acquire temporary or permanent soiling, and the work of the Institute in this field was demonstrated, and more particularly an apparatus designed to measure atmospheric dirtiness, which has already received considerable use in mills.

There are many empirical instruments and methods in commercial use for assessing the textile properties of fibres, yarn and fabrics, some of them originating in the United States. The policy of the Institute is to examine critically all such instruments and methods and report its views to members. Many of these methods were shown in operation.

The annual general meeting gave members a fuller opportunity of visiting their central research organization than has been afforded since the War. The result was highly satisfactory in that there was a large attendance of more than seven hundred visitors. Members and staff were equally pleased with the success of the occasion—members with the wide range of the work proceeding, and the staff with the interest shown by the visitors and the extent to which their work was understood and appreciated.

OBITUARIES

Sir Arthur Keith, F.R.S.

With the death of Arthur Keith on January 7, there has passed one of the most outstanding exponents in his time of human and comparative anatomy and of physical anthropology.

Arthur Keith, the son of an Aberdeenshire farmer, John Keith, was born in 1866. In 1884 he entered Marischal College as a medical student, and was there brought under the influence of James Trail, the botanist, and John Struthers, the anatomist, both of whom provided a powerful inspiration which directed him towards a scientific career. After taking medical qualifications at Aberdeen, there followed a brief interlude when he undertook medical work for a gold-mining company in Siam. But it was an interlude of importance, for in his spare time Keith made anatomical studies of the gibbons and monkeys which inhabit the tropical jungles of the Far East and thus laid the foundation of what was to become one of the main themes of his life's work, the comparative anatomy of man and apes. His first paper in this field, which appeared in 1894, dealt with the ligamentous structures of the catarrhine monkeys. In his autobiography (published in 1950), Keith records that on his return from Siam in 1892 he had already decided to embark on an anatomical career; but he had an anxious period of waiting in very straitened circumstances before he was appointed lecturer in anatomy at the London Hospital Medical School. He occupied this post for thirteen years, during which he fully established his reputation as an anatomist by his work on the mechanism of respiration and on the comparative morphology of the heart, and by his important demonstration, in collaboration with Martin Flack, of the sinu-auricular mode of the heart. In 1908 he was appointed to the much coveted position of Conservator of the Museum of the Royal College of Surgeons, a position which he occupied with great distinction until his retirement in 1933.

Arthur Keith's name will always be linked with the Museum of the Royal College of Surgeons, just as, in his time, a reference to the College immediately called to mind the name of Arthur Keith. His distinguished predecessors were essentially academic zoologists and their interests scarcely encroached on the clinical field. But, with his clinical interests and experience, Keith focused attention on the value of the Museum as one of the finest records of the structure and history of the human body, with particular reference to the surgical disabilities and disorders which may affect it. No doubt he was better known in popular circles for his work on human evolution and fossil man; but he was no less well known in the anatomical and clinical field for his numerous and important contributions to the study of applied anatomy. In 1901 there appeared the first edition of his book "Human Embryology and Morphology", the sixth edition of which was published in 1947. The embryology of this book was not based (except to a very slight extent) on original observations; but it had the novel feature of linking together the facts of embryological development with those of comparative anatomy and evolution, and of interpreting the former in terms of the latter. For this reason it proved far more stimulating to students than the more academic and orthodox text-books on human embryology, and it has been very widely used for many years. It exemplifies particularly well the remarkable facility which Keith possessed of clarifying and illuminating an abstruse subject by presenting it in a rather unusual perspective.

At the Royal College of Surgeons, Keith rapidly acquired a high reputation as a lecturer. Although by ordinary standards his delivery was not particularly good—as a speaker he was somewhat halting and hesitant—he had a capacity for making such intimate contact with his audience that each member almost felt that the lecturer was discussing problems with himself personally. From 1910 onwards, Keith devoted more and more time to the study of fossil man, and soon came to be recognized as one of the foremost authorities on this subject. The results of his investigations were published partly in book form (for example, "The Antiquity of Man", 1915) and partly in a series of scientific papers and essays. Many of the conclusions which he formulated in his earlier years, particularly his estimates of a great antiquity for modern types of man based on remains such as the Galley Hill skeleton and the Ipswich skeleton, proved later to be founded on insecure evidence. But it has to be realized that at that time fossil specimens of early man were very few and very fragmentary, and many of the techniques which are available to palæo-anthropologists to-day were as yet undeveloped. One of Keith's outstanding characteristics was a combination of great intellectual honesty with a sincere humility, a combination which is surely a mark of the truly scientific mind, and he was always ready to admit errors of interpretation when the accumulation of evidence demonstrated these. Perhaps no instance of this characteristic is more striking than his immediate acceptance of the fraudulency of the Piltdown specimens when the evidence for this was placed before him last year. As a matter of fact (though he did not himself realize it at the time) Keith actually took the first step which forty years later led to the exposure of the forgery, by demonstrating that the Piltdown skull was that of a large-brained individual similar to *Homo sapiens* and by no means the microcephalic and somewhat simian type of skull which had been exhibited in the first reconstruction from the fragmentary remains.

In 1927, Keith was president of the British Association, and it was the result of his influence on that occasion that Darwin's old home, Downe House, was acquired by the British Association. It was also his influence which led the late Sir Buckston Browne to buy and endow an estate near by for use as an institute of experimental surgery. When Keith retired from his position as Conservator of the Royal College of Surgeons in 1933, he was appointed Master of the Buckston Browne Institute, and occupied that position until he died. He continued his anthropological work there, and in 1939 there appeared (in collaboration with T. D. McCown) what was perhaps one of his best works in this field, an elaborate and careful study of the remains of palæolithic man which had been found at Mt. Carmel in Palestine. He also published in 1948 a book on "A New Theory of Evolution", in which he stressed (and in some ways perhaps rather overstressed) the factor of social segregation in racial diversification, and in 1950 his "Autobiography" appeared.

Sir Arthur Keith's scientific eminence brought him many honours and distinctions; but he remained always a modest and unassuming man. Above all, he will be remembered for his kindly personality. He was (as he himself records in his autobiography) an individualist and did not make friends very

easily among his immediate colleagues; but, for all that, he earned an affectionate regard from everyone who had met him, even from the most uncompromising of his scientific opponents.

W. E. Le Gros Clark

Mr. J. E. Sears, C.B.E.

John Edward Sears, formerly superintendent of the Metrology Division of the National Physical Laboratory and, until recently, president of the International Committee of Weights and Measures, died suddenly in Teddington Memorial Hospital on December 21 at the age of seventy-one.

The son of the late John Edward Sears, formerly member of parliament for Cheltenham, he was educated at Mill Hill and St. John's College, Cambridge, of which he was a Scholar. He obtained first-classes in mathematics and mechanical sciences and, in 1907, was awarded the University's John Winbolt Prize for studies in civil engineering. He served an apprenticeship with Wigham Richardson, Ltd., Walker-on-Tyne. In 1910 he joined the National Physical Laboratory to take charge of the metrology section of the Physics Division and thus became responsible for maintaining the Laboratory standards of measurement in length, mass, area, volume and density, as well as for the associated verification work, including the testing of precision engineering measuring equipment and gauges. In 1913, as a consequence of the transfer of test work from Kew Observatory to Teddington, the testing of watches, chronometers, hydrometers, barometers and aneroids was added to the duties of Mr. Sears's section. During the First World War these duties greatly increased, especially in the development of engineering standards, measuring techniques and apparatus for the verification of all types of limit gauges, of which more than a million were tested at the National Physical Laboratory—a demand upon the Laboratory which arose from the application by the Ministry of Munitions of the principles of interchangeable manufacture to quantity production of weapons and ammunition. For his services to the country, Mr. Sears was made C.B.E. in 1920. Another consequence was that his section became established in 1918 as the Metrology Division, with himself as its first superintendent, a post that he held until his retirement in 1946. During 1921–32 he was concurrently deputy warden of the standards at the Board of Trade.

Mr. Sears's pioneer work in metrology is without parallel in Britain. He combined outstanding powers of leadership and organization, a broad scientific knowledge, a flair for design and a clear perception of the basic metrological principles. These qualities, with his numerous contributions to the literature, his initiation and supervision of several researches of fundamental importance and the many examples of prototype measuring equipment developed under his personal direction, brought the Laboratory international renown in the subject which was of such absorbing interest to him. Among the work with which his name is especially associated may be mentioned a determination of the yard and the metre in wave-lengths of light, and of the refractive index and dispersion of air.

Mr. Sears was a member of the Institution of Mechanical Engineers and in 1948 he was awarded part of the Institution's Clayton Prize for his services to engineering science and manufacture by research and development in metrology and gauging. His presence on committees of the British Standards Institution was always in demand, particularly as chairman, and he continued his work for the Institution until the end. He was a member of the Hodgson Committee of the Board of Trade which reported in 1951 its recommendations for the revision of weights and measures legislation. Only in October last he retired from the International Committee of Weights and Measures, to which he had been elected in 1930. His election as president in 1946, a position of considerable influence and renown in the international metric organization, was a great honour not only to himself but also to the United Kingdom.

In earlier days Mr. Sears was a skilled exponent of the English style of skating, and he took a leading part in many of the social activities of the National Physical Laboratory. He had a keen interest in gardening and was a Fellow of the Royal Horticultural Society. He married in 1919 Kathleen Lucy, daughter of the late Edward Wadsworth, who survives him together with a son and two daughters.

H. Barrell

NEWS and VIEWS

Rhodesia University College: Appeal

The inaugural board of the Rhodesia University College has prepared a handsome illustrated brochure for circulation as a part of its campaign for funds and with the object of publicizing the College generally (see also p. 181). Messages are recorded therein from Lord Llewellyn, the Governor-General of the Federation of Rhodesia and Nyasaland, from Sir Godfrey Huggins, the Prime Minister of the Federation, and from other distinguished men. An outline of the history of the founding of the Rhodesia University College is given, and the 'special relationship' with the University of London which will exist in the early years is discussed. An artist's drawing of the University as it is expected to appear when the proposed buildings are completed shows an imaginative treatment of the site, which is on the outskirts of Salisbury, Southern Rhodesia. The £450,000 for which the present appeal is launched is the balance still needed of the £2,000,000 required during the early years of the College's existence. Subscriptions and any requests for further information should be addressed to the Secretary, Rhodesia University College, 115 Baker Avenue, Salisbury, Southern Rhodesia.

Dr. Walter Adams, C.M.G., O.B.E.

Dr. Walter Adams has been appointed the successor of Dr. W. Rollo as principal of Rhodesia University College from November 1955, when Dr. Rollo's interim appointment comes to its close. Dr. Adams is at present secretary of the Inter-University Council for Higher Education in the Colonies, an appointment which he has held since the inception of the Council in 1946. He was born in 1906, and graduated at University College, London, with first-class honours in history, in 1926. Between 1926 and 1933 he held a number of research and teaching

appointments in history in the University of London. In 1933 he became general secretary to the Society for the Protection of Science and Learning, a body which did invaluable work in helping to place academic refugees from Germany and other places in suitable positions. In 1938 he became secretary of the London School of Economics and Political Science, University of London—a position which he held until he took up his present one, though during 1941–45 he was seconded for service with the Foreign Office, spending some time in Washington as deputy head of the British Political Warfare Mission to the United States. He was made O.B.E. in 1945 and C.M.G. in 1952. In his present post, Dr. Adams has necessarily travelled widely and has obtained much experience of the problems of university education in Colonial territories. Early in 1954 he was awarded the honorary degree of LL.D. by the Royal University of Malta. He will take to the Federated Territories of Central Africa, which he already knows, a knowledge of the educational problems to be faced in multi-racial territories which few can rival. The great experiment in higher education upon which Central Africa is about to embark needs men of integrity, experience and forcefulness for its successful outcome, and in Dr. Adams a principal has been found who, like Dr. Rollo before him, enjoys to the full these and many other distinguished attributes.

Sir Bernard Keen, F.R.S.

Sir Bernard Keen, who has been director of the East African Agriculture and Forestry Research Organization since 1947 (see *Nature*, **160**, 184; 1947), is retiring in August. He was the first physicist to tackle soil problems in Great Britain. This pioneering work at Rothamsted Experimental Station opened up a hitherto neglected line in pure physics—the study of water distribution and movement in porous materials—as well as providing practical applications to agriculture, notably in soil cultivation, evaporation and transpiration. Hydrological problems of much importance in connexion with water resources were also clarified by the work of the Soil Physics Department. Apart from two years secondment (1929–31) to reorganize the Imperial Institute of Agricultural Research in India, and extensive visits to the United States and South Africa, he remained at Rothamsted as head of the Soil Physics Department and assistant director until 1943. During 1943–45 he was scientific adviser to the Middle East Supply Centre. In 1946 he was appointed adviser on soil conservation to the Government of Palestine, and chairman of a U.K. Government Mission to West Africa on vegetable oil production. In 1947 he made an extensive tour of East Africa to advise on regional research. The outcome was the adoption of a Colonial Development and Welfare Scheme to create the East African Agriculture and Forestry Research Organization, of which he became the first director. A nucleus of staff was available at the East African Agricultural Research Institute at Amani in Tanganyika, which was absorbed into the new Organization. The staff was increased by recruitment as the laboratories and experimental farm at the new headquarters near Nairobi approached completion. Much attention was given to the important problems of co-ordination between the long-range research of a regional organization and the territorial investigations conducted by the Agriculture, Forestry and Veterinary Departments of Kenya, Tanganyika and Uganda. Close liaison was also established with other bodies, such as the Cotton Research Station of the Empire Cotton Growing Corporation, the East African Tea Research Institute, the Overseas Food Corporation, and the Tanganyika Sisal Association Research Station.

Chemistry at Glasgow : Prof. D. H. R. Barton, F.R.S.

D. H. R. Barton, who has been appointed regius professor of chemistry in the University of Glasgow in succession to Prof. J. W. Cook (see *Nature*, **173**, 61; 1954), graduated at the Imperial College of Science and Technology, University of London, in 1940. He obtained the Ph.D. degree for work under Sir Ian Heilbron in 1942 and engaged in government work during 1942–44. After a short time in industry, he returned to the Imperial College to work in the Department of Inorganic and Physical Chemistry under Prof. H. V. A. Briscoe, at first as a junior member of staff and later as an I.C.I. Research Fellow. After a year as visiting lecturer in the chemistry of natural products at Harvard University, where he understudied Prof. R. B. Woodward, Dr. Barton returned to Britain to take up an appointment as reader in organic chemistry at Birkbeck College, University of London; he was elected professor of organic chemistry in the University of London in 1953. Prof. Barton was Harrison Memorial prizeman of the Chemical Society in 1948 and the first Corday-Morgan medallist of that Society in 1951. In 1952 he was a Tilden lecturer of the Chemical Society and was elected to the fellowship of the Royal Society in 1954. His scientific work is summarized in more than a hundred scientific communications in organic and physical-organic chemistry. He is responsible, in part, for the development of molecular rotation correlations and conformational analysis, concepts which are contributing greatly to the current rapid growth of alicyclic natural-product chemistry.

The International Union of Biochemistry

The International Union of Biochemistry, which was founded on March 1, 1953, was formally constituted at its first general assembly, held in London during January 5–6. Of the fifteen countries which adhere to the Union to date, the following twelve were represented at the Assembly: Austria, Belgium, Denmark, France, Germany, Italy, Japan, the Netherlands, Sweden, Great Britain, U.S.A. and U.S.S.R. The Assembly elected the Council of the Union, and the Council appointed from among its members the following office-bearers: *President*, Prof. M. Florkin (Belgium); *Treasurer*, Prof. E. H. Stotz (U.S.A.); *Secretary-General*, Prof. R. H. S. Thompson (Great Britain). The following delegates from the various countries at present adhering to the Union make up the remaining members of the Council: Prof. S. Akabori (Japan), Prof. J. Courtois (France), Academician V. A. Engelhardt (U.S.S.R.), Prof. A. H. Ennor (Australia), Prof. K. Felix (Germany), Prof. E. Hammarsten (Sweden), Prof. O. Hoffmann-Ostenhof (Austria), Prof. K. Linderstrøm-Lang (Denmark), Prof. K. Lohmann (Germany), Prof. R. Nicolaysen (Norway), Prof. S. Ochoa (U.S.A.), Academician A. I. Oparine (U.S.S.R.), Sir Rudolph Peters (Great Britain), Prof. J. Roche (France), Prof. A. Rossi-Fanelli (Italy), Prof. A. Virtanen (Finland) and Prof. H. G. K. Westenbrink (Netherlands). Sir Charles Harington, the former

chairman of the International Committee for Biochemistry which was set up at the first International Congress of Biochemistry at Cambridge in 1949, was elected an honorary member of the Council. Following on the unanimous decision of the Assembly, a formal application has now been made on behalf of the Union for adherence to the International Council of Scientific Unions.

British Universities Film Council

THE report of the British Universities Film Council for 1953–54 is the sixth since its foundation, which was largely due to the initiative of members of the University Educational Film Council of Cambridge. The Council has welcomed the Universities of Aberdeen and Manchester to ordinary membership, making this total now thirty-one; the Scientific Film Association has been admitted to associate membership. The report refers to a few of the many activities of the British Universities Film Council, one of which is the issue to all member institutions of a card index giving full particulars of 16-mm. films likely to be of use at some stage or other in teaching at university-level or research. This list is useful for preliminary reference purposes and gives, under subject headings, the titles of index films. Realizing that such a carefully prepared and comprehensive list may be of value to many people and organizations besides their members, the British Universities Film Council has made copies available to all who are interested. They may be obtained from the Catalogue Secretary, Royal Technical College, Glasgow.

Health Education throughout the World

THE Fifth World Health Assembly, held in May 1952, made provision for the convening of an expert committee on the health education of the public. This committee held its first meeting in Paris during December 1953, and its report has now been published (Technical Report Series No. 89: Expert Committee on Health Education of the Public. First Report. Pp. 41. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 1 Swiss franc; 1*s.* 9*d.* net; 0.25 dollar). The committee tried to outline the way people learn, and the role of the educator in health programmes; to state the broad principles of programme planning, evaluation and organization; and to describe the development and use of methods and media, and the desirable training of personnel. Particular attention has been given to the importance of the learner, the 'consumer' of health education; too often in the past health education activities have relied on the wide use of educational media with insufficient consideration of the people for whom they were intended. The report also contains examples of how actual health education campaigns have been carried out in rural, semi-rural and urban areas. It would be interesting to know whether health educators throughout the world gain more from these three short case-studies or from the detailed statement of general principles which forms the bulk of the report.

Interaction in Effects of Plant Growth Substances

VARIOUS interactions in the physiological effects of growth substances on plant development have been investigated and discussed by G. E. Blackman and R. C. Robertson-Cuninghame (*J. Exp. Bot.*, **5**, No. 14, 184; 1954). The interrelated effects of 3-indolylacetic acid and sodium 2 : 4-dichlorophenoxyacetate on the growth and development of *Lemna minor* and *Helianthus annuus* have been investigated by means of multifactorial experiments, involving three to five levels of each compound. A clonal population of *L. minor* was maintained under constant conditions of light (550 foot-candles) and temperature (25° C.) and the growth regulators were added to a phosphate-buffered culture solution (*p*H 5·1) which was changed every two days. In the *H. annuus* experiments the compounds, in aqueous solution, were placed by means of a micro-pipette on the leaves of young plants grown in a greenhouse or in the open. Indolylacetic acid, at concentrations up to 25 p.p.m., increases the relative growth-rate of *L. minor* on either a dry-weight or frond-area basis. Sodium dichlorophenoxyacetate at 0·025 p.p.m. has little effect on growth, but at and above concentrations of 0·2 p.p.m. growth is depressed. The ratio of frond area to total dry weight is increased by indolylacetic acid, but is depressed by the phenoxyacetate. In the presence of indolylacetic acid, more particularly at the higher levels, the relative inhibition of growth caused by sodium dichlorophenoxyacetate is reduced. Various results with *Helianthus annuus* are also described. The authors conclude that the results which they have obtained in these experiments cannot be explained on the concept of wholly additive effects. There is evidence that the compounds can mutually interfere in their actions, and it would seem that more than one mechanism is involved. Many of the results can be satisfactorily interpreted on the basis that the two compounds act on a common system and that they compete with one another; but the results are not compatible with the postulate that the dichlorophenoxyacetic acid directly inactivates indolylacetic acid.

Some Tungsten and Molybdenum Products

ELECTRO-ALLOYS, LTD., 47–49 Brunel Road, Acton, London, W.3, have issued an attractive and informative illustrated catalogue of their tungsten and molybdenum products. The content is printed in three languages—English, French and German—and covers the use of tungsten as a contact material, tungsten and molybdenum as lead-in-wires for glass to metal seals, tungsten welding electrodes for inert-gas arc welding, molybdenum tubes and rods, tungsten anodes for X-ray tubes, tungsten and molybdenum heaters for vacuum metallizing plant and for other special components required for the electronic and associated industries. The technical and physical characteristics of the two metals are clearly stated; whereas both metals have high melting points, low coefficients of thermal expansion and relatively good electrical conductivities at room temperature, their mechanical properties differ in that tungsten cannot be turned, threaded or drilled.

The British Gelatine and Glue Research Association

THE annual general meeting of the British Gelatine and Glue Research Association was held on December 8 at the Connaught Rooms, London, W.C.2. Mr. S. G. Hudson (Messrs. Richard Hodgson and Sons, Ltd.), chairman of council, was in the chair. In presenting the annual report, Mr. Hudson commented on the extent of the Association's scientific publications, and on the facilities now available to assist member firms. Mr. A. G. Ward, director of research, described how the original decision of the

industry, to concentrate the work of the Association on fundamental research, was gradually giving rise to results of practical significance. Mr. G. W. Odey (Messrs. Barrow, Hepburn and Gale, Ltd.) was re-elected president. Mr. Odey stressed the importance of applying the most intensive scientific examination to natural products to make the greatest use of the structure with which they have been endowed. There were no changes in the Council or Committees of the Association.

Agricultural Scholarships

The Ministry of Agriculture and Fisheries is offering a limited number of senior and junior scholarships to the sons and daughters of agricultural workmen, smallholders and other rural workers, and to persons who have been paid workers on the land for at least three years. The scholarships are for courses in an agricultural or allied subject, including veterinary science, at university departments of agriculture, agricultural colleges and farm institutes. Candidates must have attained the age of seventeen by September 30. Further information can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Room 313), 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from education offices of county councils.

The Night Sky in February

Full moon occurs on Feb. 7d. 01h. 43m., U.T., and new moon on Feb. 22d. 15h. 54m. The following conjunctions with the moon take place: Feb. 5d. 07h., Jupiter 2° N.; Feb. 14d. 14h., Saturn 6° N.; Feb. 18d. 21h., Venus 1° N.; Feb. 21d. 08h., Mercury 0·5° S.; Feb. 26d. 20h., Mars 4° S. Mercury sets at 18h. 25m., on Feb. 1, which is about 1½ hr. after sunset, and will be visible in the western sky; but the planet is rapidly drawing closer to the sun, with which it is in inferior conjunction on Feb. 12. Towards the end of the month it rises about an hour before the sun, but its declination is then 15° S. and it will not be an easy object to see. Venus rises at 4h. 45m., 5h., and 5h. 10m. at the beginning, middle and end of the month, respectively, and is visible in the eastern sky; but owing to its fairly large southern declination it does not attain a great altitude. Its stellar magnitude varies from −4 to −3·8 and the visible portion of its illuminated disk from 0·547 to 0·650. The distance of Venus from the earth varies from 67 to 86 millions of miles during February. Mars sets about 22h. 25m. during the month and is visible in Pisces from which it moves into Aries, its stellar magnitude varying from 1·2 to 1·4, largely owing to its distance from the earth increasing by nearly 20 million miles during February. Jupiter sets in the morning hours, being visible during the night; its times of setting are 7h., 6h. and 5h., on Feb. 1, 14 and 28, respectively, and it has a westward movement in Gemini, its stellar magnitude varying from −2·1 to −2·0, the decrease in brightness being due to its distance from the earth increasing by 23 million miles during the month. Saturn rises at 1h. 55m., 1h. 05m. and 0h. 10m. at the beginning, middle and end of the month, respectively. It moves slowly towards γ Librae but is stationary at the end of the month, after which it has a westward movement. Its stellar magnitude is 0·7 at the beginning and 0·65 at the end of the month, owing to its distance from the earth decreasing by 42 million miles. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Feb. 1d. 0h. 19·0m., ζ Ari. (*D*); Feb. 2d. 19h. 14·8m., 103 Tau. (*D*); Feb. 3d. 18h. 11·9m., 3 Gem. *m* (*D*); Feb. 4d. 1h. 05·3m., μ Gem. (*D*); Feb. 4d. 1h. 46·6m., μ Gem. (*R*); Feb. 4d. 23h. 45·7m., 56 Gem. (*D*); Feb. 10d. 6h. 01·4m., 13 B. Vir. (*R*); Feb. 28d. 19h. 02·6m., 133 *B*. Tau. (*D*); Feb. 28d. 22h. 08·3m., 32 Tau. (*D*), where *R* and *D* refer to reappearance and disappearance, respectively.

Announcements

The second International Seaweed Symposium will be held in the Norwegian Technical University, Trondheim, during July 13–17. Further information can be obtained from Prof. T. Braarud, Blindern, Oslo.

The annual conference of the Museums Association will be held at Birmingham during July 4–9. Further information can be obtained from the Secretary, Museums Association, 33 Fitzroy Street, Fitzroy Square, London, W.1.

The eighth Laboratory Animals Bureau Congress will be held in Oxford during March 28–29. The third symposium on "Breeding of Laboratory Animals", organized by the Bureau, will be held at the Royal Society of Medicine on May 9. Further information can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

The annual Spring Conferences in the Department of Industrial Metallurgy, University of Birmingham, will be held during March 14–15. The subject for March 14 will be "Graphitization in Cast Irons", and for March 15 "The Structure and Properties of Electrodeposited Metals and Alloys". Further information can be obtained from the Secretary, Department of Industrial Metallurgy, The University, Birmingham 15.

The Massachusetts Institute of Technology is offering assistantships and fellowships for students taking the two-year course leading to the degree of master of science in industrial management. Assistantships are valued at 1,640 dollars and fellowships at 2,300 (3,000 for married students) dollars a year. Further information can be obtained from the Chairman of the Graduate Committee, School of Industrial Management, Massachusetts Institute of Technology, Cambridge 39, Mass., U.S.A.

The Trustees of the Lady Tata Memorial Fund invite applications for grants, scholarships or fellowships for research on diseases of the blood, with special reference to leukæmia, during the academic year beginning on October 1, 1955. Further particulars and forms of application may be obtained by writing to the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, 38 Old Queen Street, London, S.W.1; applications must be submitted before March 31.

The Worshipful Company of Glass-Sellers of London is offering up to four scholarships in glass technology tenable at the University of Sheffield which, in suitable circumstances, qualify for supplementation by the Ministry of Education up to the full value of State scholarships. The scholarship examination consists of papers in chemistry, physics and pure mathematics (two as primary subjects and one as a secondary subject) together with an English language paper. Applications for entry should be made to the Registrar, University of Sheffield, Sheffield 10, before February 26.

SURVEY OF FIELD THEORY

AUTUMN MEETING OF THE PHYSICAL SOCIETY

MOST meetings of the Physical Society are intended either for the presentation of original papers or for hearing a special lecture by a distinguished scientist, usually the recipient of one of the Society's awards. The meeting held at the University of Birmingham on December 14–15 was of a rather different type. It may fairly be described as a conducted tour of one of the most interesting regions of the frontier of our present knowledge. The 'guides' were a team of specialists on field theory, under the leadership of Prof. R. E. Peierls, who gave the introductory lecture on the first day, when the president of the Physical Society, Prof. H. S. W. Massey, took the chair. The meeting was intended for experimentalists with a general knowledge of quantum mechanics and for theoreticians who do not specialize in field theory.

The lectures themselves were highly condensed summaries, so that it is not possible to summarize them further; but a general indication of their contents may be of interest to readers of *Nature*. Prof. Peierls, in the opening lecture, introduced the fundamental ideas, starting with a consideration of the normal modes of vibration of a solid. He emphasized the method of specifying quantum numbers for the different frequencies and derived from this the picture of 'sound quanta'. These sound quanta, known as 'phonons' in the physics of the solid state, carry the vibrational energy like separate particles. Prof. Peierls then discussed the Fourier analysis of the electromagnetic radiation field and its quantization. Again the quantum numbers for different frequencies specify the field, and the photons replace the phonons. He extended the description to static fields considered in terms of an exchange of longitudinal photons between the charges. The skeleton in the cupboard—the infinite energies—was brought out, rattled and then put back again. Field theorists appear to have a normal vibration between two states: in one they believe they have solved the problem of the infinities, and in the other they know that they have not. Just at present, the first state seems to have the higher occupation number. Prof. Peierls described the virtual processes in which the field theorist becomes a dishonest accountant who embezzles energy but is never found out because he makes restitution within a time fixed by the uncertainty relation.

Dr. A. Salam (St. John's College, Cambridge) gave a more detailed analysis of field quantization and extended the analysis to a field of "photons of non-zero rest mass" defined by the Klein–Gordon equation. He showed that the 'particles' had some at least of the properties of π-mesons. He expounded and re-interpreted the Dirac theory of the electron. Dr. P. T. Matthews discussed interaction between fields and analysed a number of virtual processes. These virtual processes play a very important part in, and are a distinctive feature of, modern field theory. The scattering of a photon of frequency ν by an atom which has two states of energy E_1 and E_0 is regarded as including an intermediate process in which the photon is absorbed and the atom goes from E_0 to E_1; but since $h\nu$ is not even approximately equal to $E_1 - E_0$, energy is not conserved in this process. However, there is a second process in which the photon is emitted in a new direction and the atom returns to its original state. The second stage also 'breaks' the conservation law; but the two stages taken together do not, and there is no observable breach of the law. The 'ordinary physicist' who is just reconciling himself to this situation is then told that he must also accept a situation in which the photon is emitted from the atom in changing from state E_0 to state E_1, that is, 'before' the absorption of the incident photon. He is in the position of a bank manager who has agreed, in principle, that he will grant overdrafts and is then approached by someone who wishes to 'open an account' with an overdraft! As Dr. Matthews showed, there is no logical difference, but the psychological impact of the unfamiliar idea is sharper. He showed that successive virtual processes may produce unexpected observable effects. This gave a theory of the Lamb–Retherford shift and of the 'anomalous' magnetic moment of the electron. He explained the difficulty of meson theory which arises because the fundamental constant $g^2/\hbar c$ is probably of order 10, whereas the corresponding constant in electron theory, $e^2/\hbar c$, is 1/137.

During the discussion on these papers, experimentalists asked what the field theorists had to say about experiments in which particles seem to be very individual; for example, the observation of the track of a meson in an emulsion. Prof. Peierls stated the conditions in which the particle concept remains useful, but emphasized that the field concepts are an essential feature of any relativistic theory of interactions. There was a certain amount of friendly banter between the lecturers and some of the experimentalists in the audience concerning the question whether theory had preceded or followed certain experimental results. If an onlooker may comment on this private contest, I feel that life would be dreadfully dull for the experimentalist if the theoretician could predict in advance the results of his experiments. The theory which is most useful to the experimentalist is the one which most clearly defines a limited area in which crucial experiments may be expected to produce important results.

The three lectures on the second day dealt chiefly with field interactions. Dr. Matthews considered the information about spin, parity, etc., which is derived from studies of the disintegration of π-mesons and their interactions with nucleons. The independence of charge shown by nucleon–nucleon forces was discussed and the concept of isotopic spin was introduced. Dr. G. Feldman described meson production and scattering experiments, giving particular attention to the high-energy resonance effects obtained with protons produced in the large accelerators. Prof. Peierls gave the concluding lecture, in which he summed up the earlier discussions and described some of the difficult unsolved problems connected with the heavier mesons and the hyperons. He referred—perhaps a little

wistfully—to the period in the 'thirties when it was believed that an understanding of the dimensionless constant $e^2/\hbar c$ was just around the corner, and that with this understanding all problems of fundamental particles and nuclear forces would be solved . . . whereas to-day people don't know where to stop. . . .

The Physical Society and the organizers made the conference open without fee to all who were interested. Probably about half those present were Fellows or student members of the Society and rather more than half were visitors to Birmingham. The total attendance was 135. Among this large number, there must have been a few whose background knowledge was insufficient, but the interest and enthusiasm of the meeting was maintained throughout; the audience at the last lecture was not noticeably less than that at the first. Inquiries revealed a general feeling that an additional day or half-day to give time to assimilate the material would have been useful; but this statement was repeatedly accompanied by expressions of admiration for the excellence of the lectures. It was possible to treat so much material in a short time only because very great care had been taken to devise a treatment which avoided all purely mathematical difficulties while revealing the essential unsolved problems of physical understanding.

In concluding this report, it is reasonable to ask whether this meeting should form an example for some future meetings of the Physical Society. If specialists in some other fields are prepared to give as much thought to the problems involved in explaining their work to other physicists, then they may also succeed; for example, a similar treatment of problems of supersonic flow might be very interesting. Other scientific societies may also find occasional meetings of this type acceptable to their members.

R. W. Ditchburn

THE GEOGRAPHICAL ASSOCIATION

THE annual conference of the Geographical Association held at the London School of Economics during January 4–7 concluded a further eventful year in the life of the Association, although the year's activities were sadly clouded by the death of Dr. O. J. R. Howarth, the immediate past-president, and also of Sir John Myres, a trustee, past-president and very staunch friend of the Association.

A very successful spring conference was held amid delightful surroundings at Exeter; and the summer school, under the leadership of Mr. R. C. Honeybone and Dr. K. A. Sinnhuber, embarked on a new venture by meeting at Sistrans, near Innsbruck. A second party of members also attended in August the International Conference of Teachers of Geography held at Hilversum. As an outcome of this meeting the Geographical Association's office was adopted as the headquarters for the International Union of Associations of Teachers of Geography. As the central co-ordinating body, the Association has now assumed responsibility for the development and exchange of ideas among teachers of geography throughout the world. The Association has also sponsored courses for teachers in co-operation with the Norfolk Education Committee at Wymondham College, with the Derbyshire Education Committee at Buxton, with the Lancashire Education Committee at Manchester, and with Institutes of Education at London, Nottingham, Leeds and Reading.

A lively branch activity continues, five new branches being formed during the year, thus bringing the total to forty-six, and the membership has risen accordingly and now approaches the four thousand mark. The Association has watched with care the status of geography in the schools, and one important matter upon which questions were asked in the House of Commons was concerned with the changing regulations of the Scottish Universities Entrance Board. Action was taken jointly with the Royal Geographical Society and the Institute of British Geographers in this instance. At present considerable interest is focused upon the position of geography in secondary modern schools, comprehensive schools and technical schools.

The three hundred and fifty teachers and lecturers who attended the annual conference were thus able to note with satisfaction a year of continuing vigorous activity under the presidency of Prof. S. W. Wooldridge. In a stimulating and provocative presidential address on the "Status of Geography and the Role of Field-work", Prof. Wooldridge directed attention to the need for a closer liaison between university and school practitioners of the subject, and to the problem of achieving balance between the presentation of matter and methods of teaching in the training colleges. The principles of field-work were enumerated and the need for local studies was emphasized, while the work of the Council for the Promotion of Field Studies was described together with the geographical facilities available at the four centres at Juniper Hall, Flatford Mill, Malham Tarn and Dale Fort.

The wide range of interests of the geographer was well illustrated by the supporting lectures: Mr. T. H. Elkins spoke on Liège and the problems of southern Belgium, Mr. D. J. Sinclair gave the results of a study in historical geography of some Surrey farms in the eighteenth and nineteenth centuries, Dr. F. G. Hannell lectured on the activities of the British Schools Exploring Society, and Mr. R. C. Honeybone presented an account of the summer school's alpine field-studies.

Educational aspects centred on a lecture by Mr. Charles Armour (of the British Broadcasting Corporation) on school broadcasting and the teaching of geography, the talk being enlivened by recorded extracts from programmes: and on three symposia arranged by section committees. One dealt with problems of geography teaching and their relation to preparation for the university, a second discussed the General Certificate of Education of the Associated Examining Board, and a third—supported by a demonstration class—considered techniques of diagram and map-making in class. A selection of recent geographical films was shown during the meeting, and Prof. P. W. Bryan once again contributed a 'Kodachrome' colour film, dealing on this occasion with the north-east Yorkshire moors, wolds and coast. The customary publishers' exhibition of books, maps and appliances for the study and teaching of geography, supported by nearly forty publishers, was also arranged. The Association's Standing Committee for Visual Aids, in collaboration with the National Committee for Visual Aids in Education and the Educational Foundation for Visual Aids, also mounted an exhibition of visual aids and

apparatus under the theme of "Ways of using Visual Aids in the Classroom".

Social activities at the conference included a summer schools reunion supper, a section luncheon, an Association tea, and the largest annual dinner yet held, at which Prof. P. W. Bryan, Mr. F. Spencer Chapman and Mr. Charles Armour were the guests. On January 6 the Association met jointly with the Royal Geographical Society to hear Mr. F. Spencer Chapman describe his "African Journey", and this terminated the more formal part of the conference. On the last day, however, an interesting series of excursions had been arranged to places of geographical interest. Conducted visits were paid to St. Albans, Rothamsted Experimental Station, the Port of London, the Ordnance Survey and Messrs. George Philips Map and Globe Works.

The new year is entered upon with considerable changes among the officers of the Association. Mr. T. C. Warrington is now retiring after many years of service as honorary auditor and honorary librarian, and these two offices will in future be filled by Mr. W. R. A. Ellis and Mr. L. J. Jay. Mr. L. S. Suggate becomes president for 1955, while Mr. R. C. Honeybone takes over from Prof. W. G. V. Balchin the post of honorary conference organizer. Prof. L. Dudley Stamp, Prof. E. G. Bowen and Prof. W. G. V. Balchin have been elected trustees of the Association.

W. G. V. Balchin

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT NEWCASTLE UPON TYNE

More than four hundred science masters met in King's College, Newcastle upon Tyne, during the week between Christmas and New Year for the annual meeting of the Science Masters' Association. The world-wide reach of the Association is shown by the fact that teachers were present from Ceylon, Nigeria, Uganda and Natal; also present were Mr. Withers, secretary of the Education Section of the Federation of British Industries; Dr. Dewar, representing Imperial Chemical Industries, Ltd.; and Mr. Obourn, an American observer from the Paris headquarters of Unesco.

The first evening was the occasion of the presidential address by Dr. C. I. C. Bosanquet, rector of King's College. This was delivered to a crowded audience in the large lecture theatre of the new Chemistry Building, remarkable for the excellence of its acoustics and of its air-conditioning system. Dr. Bosanquet's address was entitled "In Praise of Natural Philosophy" and was a plea for the broadening of the school curriculum for both the science and the arts specialists; the scientist, he said, is at present given a training only in a series of unrelated subjects, and the arts specialist is deprived of any further acquaintance with the great processes of Nature. Dr. Bosanquet quoted figures which showed that while the number of pupils taking science in schools is steadily rising, the number taking arts is almost stationary; and there is still a considerable proportion of boys in the public schools doing little or no science at all. As an example of the synthesis involved in the term 'natural philosophy', Dr. Bosanquet dealt at some length with the life of Thomas Young, who was equally good at so great a variety of subjects. Dr. Bosanquet wants it to be possible for a student on reaching the university to change over from an arts course to a science one and vice versa. He concluded by emphasizing the necessity for inculcating a sense of responsibility in the young scientist; he thought that wars are less likely to come from irresponsible rulers than from the apathy of those they rule; the young scientist should understand clearly that, in any future war, his chance of remaining unhurt is small.

Among its many activities, the Association administers a trust fund for the presentation of a lecture on science and citizenship, usually given every second year. This year the lecture was by Dr. Eric James, High Master of Manchester Grammar School, and it will live long in the memories of those who heard it as a great occasion in the history of the Association; an excellent speaker giving out constructive thought at white heat in a splendid theatre to another crowded audience made it a remarkable experience. Dr. James took the view that the scientist cannot be a neutral technical expert, and must take full responsibility for the consequences of his work. Even if that work be apparently without any practical application whatever, he still owes the opportunity to do that work to the social structure in which he lives, and he can therefore not afford to be indifferent to circumstances affecting that structure.

Dr. James expressed concern at the consequences of television, the "most politically significant invention since printing", since it creates masses of uncritical observers, and might prevent the heretic and the oddity, on whom progress depend, from having any public voice at all. He thought also that as more and more of the best brains become involved in scientific pursuits, there is a grave risk that the level of ability in political administration may fall; and it is therefore essential that the scientist should have an education making him capable of taking over the work of government.

The more strictly scientific activities during the meeting included lectures by members of the science and applied science faculties of King's College. Notable among these was one entitled "Demonstrations in Optics", by Prof. W. E. Curtis, who is an outstanding example of that not too common combination, high ability as a scientist and great skill as a showman; all his very large number of experiments were most beautifully presented.

On the same morning, Prof. W. F. K. Wynne-Jones gave a lecture on the presentation of physical ideas in chemistry, and Prof. A. D. Hobson followed up a lecture on the marine fauna of the British Isles with an afternoon visit for members to the Marine Laboratory at Cullercoats.

The second full day began with a lecture by Dr. R. McWeeny on the impact of quantum theory on the teaching of physics and chemistry; one by Prof. T. S. Westoll on "Living Fossils"; and one by Prof. G. S. Rushbrooke on some characteristic features of twentieth-century physics. Prof. Westoll's lecture, on a semi-palæontological subject, marks a somewhat unusual departure for the Association, and indicates a steady broadening of its subject-matter. King's College has plans for a large new department of geology, in view of the importance of that study to the north-eastern area of Britain.

The two main afternoons were occupied by visits to many different industrial organizations, such

visits being indeed a strong point of the meeting, since the North East includes so many types of heavy and light industry. The sites visited included the Wilton and Billingham works of Imperial Chemical Industries, Ltd., the Pyrex glass works at Sunderland, two coal mines, factories making springs and pumps, works for gas, soap and mining machinery, the Ediswan lamp and valve factory, Parsons and Marine Engineering Turbine Research and Development Association, Reyrolles switchgear works, and the premises of Associated Lead Manufacturers, and of the Grubb Parsons Optical Co., Ltd. A visit was also made to the Radiochemical Laboratories at Durham, where accurate analyses of small quantities of rare gases are performed. Samples of gas from the upper atmosphere, taken in the United States by means of rockets, are sent to Durham for analysis.

The meeting also included discussions on M.K.S. units, on science teaching in secondary modern schools, and on science and religion.

The final morning again began with lectures, by Dr. S. L. Ranson on the metabolic activities of cellular particles, Dr. J. H. Wilkinson on small-scale organic preparations, and Mr. P. C. G. Isaac on public health engineering.

During the meeting, all the science and engineering laboratories of King's College were open, and members, manufacturers and publishers again gave their usual exhibitions; the manufacturers and publishers expressed great satisfaction at their excellent housing in the new Chemistry Building.

Special exhibitions were also arranged by the Northern Lighting Bureau of the Electric Lamp Manufacturers' Association and by the British Iron and Steel Federation. For the former, the area representative, Mr. R. J. Fothergill, had prepared a fascinating experimental display, including, in a corridor, an illuminated sign, the light from which detected whether one's shirt had been washed in particular detergents. For the Iron and Steel Federation, Capt. J. F. W. Mudford, area training organizer, had a comprehensive collection of all the Federation's educational literature, together with specimens and static models of its productions.

The social side of the meeting was catered for by an evening concert in King's Hall, preceded by a reception at which members and their ladies were welcomed by the Lord Mayor and Lady Mayoress of Newcastle upon Tyne, the Rector of King's College, and the Chairman of the Association and Mrs. Dyball. The playing in of the Lord Mayor by the Northumbrian pipes of Mr. Jack Armstrong was a touch characteristic of the locality; and the concert, which included piano solos by Miss Margaret Evans, Northumbrian songs by Mr. William Robinson, and pipe music by Mr. Armstrong, was much appreciated.

The Association is deeply indebted to all those who helped with the preparation of the meeting, and especially to the registrar, Mr. G. R. Hanson; to Prof. W. F. Cassie, who arranged the tours of the engineering laboratories; and to Dr. Chalmers Burns, director of music, who obtained the artistes for the concert.

It may be permissible to quote the final comment of a witty member from a famous Scottish public school, who said that he was going home "a wider and a humbler man; wider in that he had been fed so well, and humbler in that he had learnt so much".

W. H. Dowland

THE BRITISH FLORA DURING 1954

THE flora of the British Isles has been the subject of such thorough investigation, as compared with most other countries, that advances in knowledge can now be expected mainly from the application of new techniques and from the closer study of small groups. These were the approaches adopted by most of the exhibitors at the annual exhibition meeting of the Botanical Society of the British Isles, arranged in the lecture room of the British Museum (Natural History) on November 28. It was evident that cytology and careful analysis of variation are still yielding some of the most interesting results, and that the study of hybrids is proving of far greater importance than was supposed a few years ago.

One entirely new development was illustrated by H. J. M. Bowen (Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell). By means of activation analysis—the ashes being irradiated with neutrons in the Harwell pile, and the radioactive strontium then separated from all the other elements by conventional methods—he has determined the amount of strontium present in material from about forty species of plants. He finds that plants growing on ordinary soils contain 1–50 parts per million of strontium, but in the limited areas in Britain where the soils contain large concentrations of this element (as the sulphate, celestite; or as the carbonate, strontianite), plants are found to contain up to 2 per cent or more of strontium by dry weight. All the species examined were found to be accumulators. The Avon Gorge is one of the areas where considerable concentrations occur in the rocks, and the concentrations in some of the rare species found there (for example, *Arabis stricta* 1·06 per cent, *Anisantha madritensis* 1·16 per cent) are also high. Further investigation may show that the distribution of certain plants may be related to concentrations of strontium.

A number of very interesting hybrid grasses were exhibited. Dr. A. Melderis (British Museum (Natural History)) showed *Festuca rubra* × *Vulpia membranacea*, which was collected by several members on the Society's field meeting at Southport, and later by Miss M. McCallum Webster on dunes at Sandwich. In both places it evidently occurred in some quantity. A similar hybrid was exhibited by C. E. Hubbard (Royal Botanic Gardens, Kew) from Vazon, Guernsey. He also showed *Agrostis stolonifera* × *A. semiverticillata* from Vazon, *Festuca arundinacea* × *Lolium perenne*, and a variegated form of *Poa annua* from a shrubbery at Kew. With N. Y. Sandwith (Royal Botanic Gardens, Kew) he exhibited *Agropyron repens* × *Hordeum secalinum* (× *Agrohordeum langei*), collected by Mrs. C. I. Sandwith in 1945 from Shirehampton.

Two other hybrids exhibited which are new to the British list were *Carex binervis* × *C. punctata* from rocks near Barmouth, shown by P. M. Benoit, and *Mentha aquatica* × *M. rotundifolia* (*M.* × *maximiliana*), collected by Miss B. M. Sturdy near Penzance, and shown by R. Graham. J. D. Lovis (University of Leeds) provided an interesting demonstration of ferns. *Asplenium adulterinum* is a tetraploid species ($2n = 144$), intermediate in morphology between *A. viride* and *A. trichomanes*, and is found on serpentine rocks in central Europe and Fenno-Scandinavia, where it usually grows with one or

other of the species mentioned. It may yet be found on serpentine rocks in the more remote parts of Scotland. Investigation showed that it is amphidiploid, with the diploid form of *A. trichomanes* ($2n = 72$) and *A. viride* ($2n = 72$) as its probable parents. The hybrids *A. trichomanes* ($2x$) × *A. adulterinum*, *A. adulterinum* × *A. trichomanes* and *A. viride* × *A. adulterinum* have been synthesized. *Asplenium* × *breynii*[1] was also exhibited.

Another aspect of the importance of the study of hybridity was demonstrated in the exhibit by Prof. T. G. Tutin (University College, Leicester) of British material of *Symphytum*. The plant usually referred to as *S. peregrinum*, which is frequent, and very variable, appears to be the central part of a hybrid swarm from the cross between *S. officinale* and *S. asperum*. Dr. E. F. Warburg (Department of Botany, University of Oxford), who has been re-examining material of alleged hybrids in connexion with work on the new "Plant List" which the Society has in preparation, exhibited herbarium specimens of some of the plants on which published names have been based. He found that some of these 'hybrids' are morphologically convincing; but others, such as *Lotus* × *davyae* and *Potentilla* × *cryeri*, are apparently only forms of one of the alleged parents.

The University of Manchester exhibit on *Senecio* covered an excellent example of a polyploid hybrid which is fertile, and this is to be described as a new species. *Senecio squalidus* ($2n = 20$) was crossed with *S. vulgaris* ($2n = 40$), and from the hybrid ($2n = 30$), by colchicine treatment, the synthetic polyploid ($2n = 60$) was produced. This was exhibited in three forms: mid-ray, long-ray and rayless. The synthesized plant was found to agree in morphological characters with a natural polyploid found in North Wales by H. E. Green in 1948, which was seen wild in quantity again this year, and which has persisted in cultivation since its discovery. A technique for growing species of *Euphrasia*[1], which are partially parasitic, was demonstrated last year by P. F. Yeo (University of Cambridge). This year he exhibited artificial hybrids of *Euphrasia occidentalis* with *E. salisburgensis* var. *hibernica* and with *E. pseudokerneri*, which had been grown with their parents on *Medicago lupulina* as the standard host.

In 1952, *Artemisia norvegica* was discovered in north-west Scotland[2]. Critical examination by Prof. E. Hultén of the circumpolar group of closely related species to which this belongs has shown that the plant from Scotland is distinct, and it has been described as ssp. *scotica*[3]. The type material on which the new taxon is based was exhibited by the Department of Botany, British Museum (Natural History). The Department also showed specimens of *Rubus arcticus* from its collection labelled as collected from Ben Lomond and "Ben-y-glo", for comparison with one from "Ben Lawers, 1837" recently detected in Cosmo Melville's herbarium in the Butler Museum, Harrow, by R. M. Harley. This circumpolar species occurs in Scandinavia, and further search may well confirm it as a British plant. The Museum also exhibited interesting sheets of *Carex lepidocarpa* ssp. *scotica*[4], *Nuphar pumila* and *N. intermedia*[5], and viviparous grasses[6] to illustrated recent papers in *Watsonia*. P. S. Green (Royal Botanic Gardens, Edinburgh) showed seeds, specimens and a map of the distribution of *Stellaria nemorum* spp. *glochidisperma*, which he has recently described for Britain[7].

Dr. S. M. Walters (Botany School, University of Cambridge) demonstrated the use of the category 'sub-species' in taxonomy, pointing out that in current practice three different situations are involved, namely, the geographical sub-species, the "cyto-sub-species" and the "ignorance sub-species". He suggested that the use of the same category for genetically different situations is in no way either inconvenient or undesirable, and illustrated the point with reference to the diploid, tetraploid and hexaploid cytodemes of *Polypodium vulgare* L., for which he advocated a sub-specific category. Dr. K. B. Blackburn and Miss A. W. Adams (King's College, Newcastle upon Tyne) provided an interesting exhibit of cytology of *Herniaria*. In the *glabra* group of the sub-genus *Eu-herniaria* the chromosome numbers show a polyploid series on a base of nine. S. Challenger (University of Bristol) exhibited flowers of *Dianthus gratianopolitanus* from Cheddar Gorge, which show a surprising amount of variation for a species with such a restricted distribution in Britain. Living plants, silhouettes of the fruit papillæ and distribution maps of *Galium pumilum* in Britain were shown by K. M. Goodway, who suggested that this could be tentatively divided into western ($2x$), montane (? hybrid), northern-limestone ($4x$), southern-chalk (? $8x$) and Cheddar (? $8x$) forms. D. J. Hambler (Queen Mary College, London) illustrated the cytology and ecology of Orobanchaceae and semi-parasitic members of the Scrophulariaceae[8], A. C. Jermy (University College, Leicester) showed variations in *Carex nigra* and its hybrids, and M. C. F. Proctor (Nature Conservancy) of *Helianthemum canum*.

The main exhibit concerned with the distribution of British plants was that of the Society's distribution-maps scheme[9], on which three full-time and two part-time assistants are now engaged in addition to the director. The nine hundred 10-kilometre squares for which volunteers have already accepted responsibility for the contribution of records were indicated on a large map, and further offers were received during the exhibition. Dr. C. D. Pigott (University of Sheffield) provided an exhibit to illustrate the fact that many northern plants reach the south-eastern limits of their distribution, and many southern plants their north-western limits, along a line that runs diagonally across central England, and used *Asplenium viride* and *Cirsium acaule* as examples. These meet but never overlap, and it is significant that near Sheffield the reproductive capacity of *C. acaule* is greatly reduced. There seems little doubt that this phytogeographical boundary is also a significant climatic boundary. J. E. Lousley showed photographs of the very rare orchid *Epipogium aphyllum* from a new locality in Oxfordshire. Dr. T. D. V. Swinscow exhibited photographs of ferns at Leagrave Station, Bedfordshire, where nine species had been found. They included both calcicole and calcifuge ferns, and their occurrence on a railway platform suggests that distribution of the spores may be facilitated by the traffic. R. A. Graham provided evidence that *Cypripedium calceolus* occurred in Yorkshire in 1954. P. M. Benoit showed *Salicornia perennis* from Barmouth and Mochras, Merioneth, as the first certain records for Wales. W. S. Lacey (University College of North Wales, Bangor) had an exhibit to illustrate his discovery of *Orchis traunsteineri* in Caernarvonshire. Sub-fossil botany was represented by an exhibit by J. W. Franks (University College, Leicester) of plants from the '*N*' horizon in

the Esthwaite basin. The drop in tree pollen, rise in grass pollen and occurrence of *Plantago lanceolata* suggest that this horizon may represent the beginnings of cultivation in the area.

A useful warning to modern collectors and commentators was implied in the exhibit by Mrs. H. N. Clokie (Department of Botany, University of Oxford) of selected sheets from the Du Bois (1690–1723) and Sherardian (1700–26) herbaria. These showed the confusion and loss of information which can result from illegible labels, or from mounting plants which could not be certainly associated with their labels. The Library of the British Museum (Natural History) displayed a magnificent series of unpublished drawings prepared for Church's "Types of Floral Mechanism" and unpublished text. The view was freely expressed that the publication of these fine additional drawings would be a valuable addition to the book already available.

A full account of the exhibits will appear in due course in the *Proceedings* of the Society. The meeting was attended by about two hundred and eighty members and guests. J. E. Lousley

[1] Lousley, J. E., *Nature*, **173**, 113 (1954).
[2] Lousley, J. E., *Nature*, **171**, 335 (1953).
[3] Hultén, E., *Nytt Mag. Bot.*, **3**, 67 (1954).
[4] Davies, E., *Watsonia*, **3**, 71 (1953).
[5] Heslop-Harrison, J., *Watsonia*, **3**, 7 (1953).
[6] Wycherley, P. R., *Watsonia*, **3**, 41 (1953).
[7] Green, P. S., *Watsonia*, **3**, 122 (1954).
[8] Hambler, D. J., *Nature*, **174**, 838 (1954).
[9] Walters, S. M., *Nature*, **173**, 1079 (1954).

HYDRAULIC TRANSPORT OF COAL

TRANSPORT of coal from the mines to the user represents an appreciable proportion of the energy in the fuel. Normally this is done by rail or sea transport; but transportation through pipes as a suspension in water is another possibility. The advantages of hydraulic transport over short distances within the workings of the colliery are apparent—either underground or on the surface, or even as an alternative to normal cage winding. There is, however, the possibility that hydraulic transport of coal could be operated over much longer distances; this has already been accomplished up to five miles, and a hundred-mile pipe-line is planned in the Pittsburgh area. These advantages and many others were described by Dr. Idris Jones, director-general of research, National Coal Board, in an introductory address to a colloquium on "The Hydraulic Transport of Coal" held by the National Coal Board in London during November 5–6, 1952 (pp. vi+75. London: National Coal Board, 1954), which was opened by Sir Charles Ellis.

Although there is in existence much experimental data on the transport of solid material by water streams in open channels and pipes, the numerous factors involved have hindered the formulation of any theory which will give a full understanding of the transport process in pipes. The purpose of the colloquium was to assemble and compare such results as are available and to discuss tentative theories. The first four papers dealt mainly with fundamental theory and the development of dimensionless groups characterizing the flow of suspensions through pipes, with lump sizes up to 4 in. Some of the authors admitted that the present theory is inadequate, and it is evident that this is only the beginning of research on this subject. The second group of four papers described the development of coal feeders and experimental installations in France and at Markham Colliery.

The discussion on the papers is included in the publication, and the proceedings form a useful basis for further study of a subject which is becoming of increasing practical importance. H. Heywood

RECENT WORK IN MAYAN ARCHÆOLOGY

OVER a long period of years, the Carnegie Institution, through its Archæological Department, has produced a most valuable series of publications, most of which deal with the Maya area. The shorter studies in this series have appeared in volumes of *Contributions*, of which that under review is a useful example*.

No. 52, by Howel Williams, deals with some human and animal footprints first discovered seventy years ago on the outskirts of Managua, Nicaragua, which aroused a great deal of interest when they were found, owing to their supposedly great age. This was based on the considerable depth of four metres at which they were found, and was estimated at 50,000 years or more. Further examples were found at the same horizon in 1941, so it has been possible to study the question afresh. Williams shows that the deposits in and under which they occur are pumices and mud-flows associated with vulcanicity, which must have been accumulated at a great rate, so that their age has been grossly exaggerated. The prints are abundant, and may well have been made by people fleeing from a rain of ash from the volcano Masaya. On the scanty evidence of a sheard of Usulutan ware found on the site at a considerably higher level, it is concluded that the footprints are between 3,000 and 5,000 years old. The author holds out little hope of obtaining material for radiocarbon dating, so it is unlikely that this estimate can be improved on.

The second paper, No. 53, by A. V. Kidder and E. M. Shook, describes the partial excavation of a complex temple mound containing at least two important burials at the Maya site of Kaminaljuyú, near Guatemala City. The authors, with J. D. Jennings, have already published an important work on Kaminaljuyú; but it is a very large site and a great deal remains to be done. This was largely a rescue dig, necessitated by the destruction of part of the mound by brick-making activities. The mound proved to belong to the Miraflores phase of the Pre-Classic or Middle Culture Period, dating in all probability from the first part of the first millennium B.C.; the authors had suspected that this might be so, but had been loth, in the absence of positive proof, to ascribe so large and complex a structure to this early period. The importance of the work lies mainly in the recognition of this fact, which may make it necessary to postulate the emergence of 'Classic' social structures, for example, a ruling class, in pre-Classic times, and perhaps to revise our chronological nomenclature accordingly.

Something is known of the archæological record of the Maya in Northern Yucatan from the Formative

* Contributions to American Anthropology and History. Vol. 11, Nos. 52–56. (Publication 596.) Pp. vi+236. (Washington, D.C.: Carnegie Institution of Washington, 1954.) 6.75 dollars, paper; 7.50 dollars, cloth.

Period, before, say, the fourth century A.D., down to the fall of the city of Mayapan about a century before the Spanish conquest; but after that there is a gap which is difficult to explain, just when traditions begin to throw some light on Maya history. In No. 54, R. L. Roys studies the Spanish Colonial sites, particularly the churches and convents, in this area and their relations with Maya ruins, in the light of his intimate knowledge of the country and the documentary sources. He concludes, not only that many Colonial towns and villages were on pre-Conquest sites, but also that the churches and plazas generally occupy the old ceremonial centres. This fact, and the destruction of the old buildings to provide materials for the new, are largely responsible for the gap in the archæological record, and it should now be possible to fill it by exploring suitable post-Conquest sites.

In No. 55, G. Strömsvik describes three superimposed ball-courts at the famous Classic Maya site of Copan, Honduras, together with comparable examples elsewhere. The courts are structures enclosed by lateral walls for playing a team game with a rubber ball, which in one form or another was widespread in middle America in ancient times, and which still survives on flat courts in remote parts of Mexico. It is possible that the first court at Copan, perhaps dating from the fifth century A.D., is the oldest yet discovered, and the latest may date from late in the eighth century. The latter is remarkable for the presence of three stone macaw heads tenoned into each side of the lateral structures; these may be related to the stone rings which formed a kind of goal in later courts. A feature of the report is a reconstruction drawing of the latest court and its surroundings by Miss Tatiana Proskouriakoff.

No. 56, by R. E. Smith, is a short paper describing pottery, believed to be of late Classic date, from a rubbish pit in Alta Verapaz in Guatemala. It is rather a specialized subject, and its importance lies in the fact that the archæology of Alta Verapaz is very little known. G. H. S. BUSHNELL

EFFECT OF STREPTOMYCIN ON VARIOUS ENZYMES RESPONSIBLE FOR SYNTHESES AND DEGRADATIONS OF HIGHER SACCHARIDES

By DR. S. A. BARKER, DR. E. J. BOURNE, PROF. M. STACEY, F.R.S., and R. B. WARD
Chemistry Department, University of Birmingham

PREVIOUS workers have shown streptomycin to affect certain enzyme systems, its inhibition of the oxalacetate–pyruvate condensation[1] being particularly important. However, little has been reported of its influence on enzymes responsible for the synthesis and degradation of oligo- and polysaccharides, and this formed the subject of the investigation now described. It was considered that streptomycin might exert part of its powerful antibiotic action against mycobacteria by blocking some of the enzyme systems which build up their complex polysaccharide molecules. Such a hypothesis is particularly attractive in the case of *Mycobacterium tuberculosis*, since certain of the specific polysaccharides of this organism and the antibiotic show structural similarities, inasmuch as they are both glycosides with furanose and glucosamine components (D-arabofuranose with D-glucosamine[2] and streptofuranose with *N*-methyl-L-glucosamine, respectively). Furthermore, since streptomycin is mainly of a carbohydrate nature, it was felt that it might serve as either a donor or a receptor in suitable transglycosylation reactions[3] and give rise to modified streptomycins; if this happened, it could account for the relative ease with which mycobacteria can adapt themselves to streptomycin.

In order to test these theories, each enzyme solution was incubated with the appropriate substrate, in the presence and absence of streptomycin sulphate (0–15 per cent), the two digests being adjusted to the same *p*H to counteract the acidity of the antibiotic salt. At intervals, the digests were analysed for sugars by paper chromatography using (*a*) the organic phase of a butanol (40 per cent) – ethanol (10 per cent) – water (49 per cent) – ammonia (1 per cent) mixture as the solvent, with aniline hydrogen phthalate[4] and naphtharesorcinol[5] detector sprays, or (*b*) the benzylamine method[6], with ninhydrin as the detector. In addition, each sample was examined in 0·2 *N* acetate buffer (*p*H 5·0) on four identical ionophoretograms (600 V., 4 hr.), which were developed, severally, with aniline hydrogen phthalate[4,7] naphtharesorcinol[5], a modified Elson–Morgan reagent, and alkaline diacetyl/α-naphthol[7].

Although no evidence was obtained with the enzymes studied of a streptomycinase, or of a transglycosylation giving rise to a compound analogous to the naturally occurring mannosyl streptomycin, several interesting effects were observed, as follows:

Invertases and transfructosylases[8]. Commercial yeast 'invertase' (British Drug Houses, Ltd.), acting on sucrose, gave fructose, glucose, di- and tri-saccharides. In the presence of streptomycin sulphate (15 per cent), the reaction was retarded, particularly as regards the formation of the higher saccharides. With the 'invertase' of *Aspergillus niger* (strain 152[9]), used as a cell-free extract from a culture grown on sucrose, the effect of streptomycin sulphate was even more apparent. Whereas the enzyme normally converts sucrose into glucose, fructose and higher saccharides, the presence of streptomycin sulphate in concentrations of 0·01 per cent and higher caused a marked inhibition of fructose formation and prolonged the life of the higher saccharides. A possible explanation of these phenomena is that invertase- and transfructosylase-activities are not always exhibited by a single enzyme, as is widely believed (cf. ref. 8), but that there may be two distinct enzymes, one of which is more sensitive to streptomycin than the other; further work to test this hypothesis is envisaged.

Nigeran synthesis. The addition of streptomycin sulphate (10 per cent) to the sucrose (10 per cent) – mineral medium used to culture *Aspergillus niger* (strain 152), and also a related strain, caused marked increases (ten- and three-fold, respectively) in the percentages of nigeran[10] in the dried mycelia. Smaller concentrations of streptomycin sulphate had correspondingly smaller effects.

Panose synthesis. A cell-free extract of *Aspergillus niger* (strain 152) produced, *inter alia*, glucose, *iso-*

maltose and panose when incubated with maltose[11]. In the presence of streptomycin sulphate, at concentrations greater than 0·1 per cent, the formation of *iso*maltose and panose was retarded.

Amylomaltase. A cell-free extract of *Escherichia coli* (Monod strain) which had been cultured on maltose, when incubated with maltose, produced glucose, fructose, maltotriose, maltotetraose, etc.[12]. In the presence of streptomycin sulphate (15 per cent) the formation of fructose, which arises from enzymes other than amylomaltase, was markedly reduced.

Other enzyme systems. Five other enzymic processes were found to be inhibited slightly by streptomycin sulphate (15 per cent); they were: (*a*) dextran synthesis from sucrose by the dextransucrase of *Betacoccus arabinosaceous*; (*b*) oligosaccharide synthesis from lactose by the transgalactosylase of *Aspergillus niger* (strain 152); (*c*) oligosaccharide synthesis from cellobiose by almond emulsin[13]; (*d*) the hydrolysis of amylose by salivary α-amylase; and (*e*) the hydrolysis of amylose by soya bean β-amylase[14]. There was no detectable effect of the antibiotic (15 per cent) on (*a*) the liberation of phosphate from dipotassium α-D-glucose-1 phosphate by phosphorylase; (*b*) oligosaccharide synthesis from cellobiose by *Aspergillus niger* extracts[15]; or (*c*) phosphate liberation from α-glycerophosphoric acid and dipotassium α-D-glucose-1 phosphate by bovine intestinal phosphatase.

Thus it will be seen that streptomycin has a modifying effect on some of the enzyme systems concerned with the synthesis of higher saccharides, and a more detailed study of these is being made.

We are indebted to the Glaxo Laboratories, Ltd., for the generous provision of streptomycin sulphate and for financial assistance. [Nov. 24.

[1] Oginsky, E. L., Smith, P. H., and Umbreit, W. W., *J. Bact.*, **58**, 747 (1949). Smith, P. H., Oginsky, E. L., and Umbreit, W. W., *ibid.*, 761 (1949). Umbreit, W. W., and Tonhazy, N. E., *ibid.*, 769 (1949).
[2] Haworth, W. N., Kent, P. W., and Stacey, M., *J. Chem. Soc.*, 1211, 1220 (1948).
[3] Barker, S. A., and Bourne, E. J., *Quart. Rev.*, **7**, 56 (1953).
[4] Partridge, S. M., *Nature*, **164**, 443 (1949).
[5] Forsyth, W. G. C., *Nature*, **161**, 239 (1948).
[6] Bayly, R. J., and Bourne, E. J., *Nature*, **171**, 385 (1953).
[7] Foster, M. C., and Ashton, G. C., *Nature*, **172**, 958 (1953).
[8] Bacon, J. S. D., *Ann. Rep. Chem. Soc.*, **50**, 281 (1953).
[9] Barker, S. A., Bourne, E. J., and Carrington, T. R., *J. Chem. Soc.*, 2125 (1954).
[10] Barker, S. A., Bourne, E. J., and Stacey, M., *J. Chem. Soc.*, 3084 (1953).
[11] Barker, S. A., and Carrington, T. R., *J. Chem. Soc.*, 3588 (1953).
[12] Doudoroff, M., Hassid, W. Z., Putman, E. W., Potter, A. L., and Lederberg, J., *J. Biol. Chem.*, **179**, 921 (1949). Barker, S. A., and Bourne, E. J., *J. Chem. Soc.*, 209 (1952).
[13] Peat, S., Whelan, W. J., and Hinson, K. A., *Nature*, **170**, 1056 (1952).
[14] Donatelli, L., and Galeotti-Fiori, A., *Chem. Abs.*, **42**, 1662 (1948).
[15] Barker, S. A., Bourne, E. J., and Stacey, M., *Chem. and Indust.*, 1287 (1953).

EXCHANGE REACTIONS IN THE ENTRY OF CATIONS INTO PLANT TISSUES

By R. SCOTT RUSSELL and M. J. AYLAND
Department of Agriculture, University of Oxford

It is well established that when actively metabolizing plant roots or tissue slices are transferred to solutions containing higher concentrations of ions than those to which they were previously exposed, a rapid entry of ions occurs, but within a few minutes the rate of entry decreases. Conversely, when tissues are transferred to more dilute solutions an initial rapid outflow is observed[1,2]. Conflicting interpretations of this initial flux have been advanced. It has been widely held that exchange reactions or adsorption at the cell surface are the first step in ionic entry[3–6]. Evidence that the rate of absorption is not controlled by diffusion into the tissues accords with this view[7]. Recently, however, Hope and Stevens[2], and following them, Butler[1], have regarded the initial flux as a diffusion process. In his later work, Hope has suggested that non-diffusible anions influence the rate of absorption; but he has retained his earlier concept that ions diffuse into the "apparent free space" of tissues.

The use of radioactive isotopes makes it a simple matter to study the competition of ions for entry into tissues over short intervals, and the relative importance of exchange and diffusion processes can in this way be examined. If diffusion is the rate-limiting process, the entry of one cation will not be affected by the presence of another cation in low concentration. However, if the presence of sites on which exchange or adsorption occurs is the controlling factor, inter-ionic competition is to be expected even in the shortest experimental periods. Experiments of this type have been conducted using washed carrot disks, detached barley roots and intact barley plants. In Table 1, representative results are shown for the absorption, over periods of 5–20 minutes, of labelled rubidium and cæsium in the presence and absence of other monovalent cations. Even in five minutes the absorption of the labelled ion is markedly reduced by the presence of other monovalent ions. The percentage reduction changes little if the experimental period is increased to twenty minutes. These results are interpreted as indicating that diffusion is not a significant factor determining the rate of the initial entry of ions into the tissues studied; it is assumed that the process depends on exchange reactions at or near the cell surface. The mechanism is, however, not "passive" in the sense that Broyer[3] has used that word to denote processes independent of metabolism. It has been found that the initial inward flux can be reduced by 2 : 4-dinitrophenol and by sodium azide at 25° C. (Table 2). In work with the latter substance it has been demonstrated that the observed effect was not due to the sodium ions in

Table 1. Interaction of Cations in the Initial Flux of Absorption (Temperature 25° C.)

Tissue	Labelled ion $M \times 10^{-3}$	Interfering ion $M \times 10^{-3}$	% reduction of absorption of labelled ion induced by interfering ion after 5 min.	10 min.	20 min.	Statistical significance (P)
Carrot disks	Rb 0·2	K 12·8	72·5	81·3	82·5	(Unreplicated)
,,	Cs 0·2	K 12·8	65·6	74·1	74·0	0·001
,,	Cs 1·6	K 12·8	57·9	57·1	55·7	0·02
,,	Cs 0·2	Rb 0·2	48·2	—	—	0·001
,,	Cs 0·2	Rb 0·2	25·7	—	—	0·001
Barley roots	Cs 0·2	Rb 12·8	64·1	72·4	84·6	0·01
Intact barley	Cs 0·2	Rb 0·2	30·4	—	—	0·001

Table 2. Effect of 2 : 4 Dinitrophenol and Sodium Azide on the Absorption of Cæsium by Plant Tissues in a Five-Minute Period at 25° C.

Tissue	Cæsium $M \times 10^{-3}$	Azide or DNP $M \times 10^{-3}$	Absorption μgm./c.c. tissue	% reduction by DNP or azide	Statistical significance (P)
Carrot disks	0·2	DNP 0·1	61·56	41·0	0·001
"	1·6	DNP 0·1*	526·11	25·3	0·01
Barley roots	1·6	Azide 0·2	29·16	14·0	0·01

* Administered for 30 minutes immediately before absorption period.

sodium azide. Other aspects of these studies will be discussed elsewhere.

In experiments with intact plants it has been possible to demonstrate ionic interactions in other phases of the absorption process[3]. In experimental periods of four hours it has been found that the interaction of potassium with rubidium is different with respect to (*a*) the absorption of rubidium, and (*b*) its transference to the shoots. Moreover, the nature of these interactions is dependent on the initial nutrient status of the plants (Table 3). These results indicate that the two ions must interact in at least two distinct phases of the absorption process, namely, the initial entry into the roots and in the mechanism whereby ions are transferred across the symplast to the stele. The complexity of the processes in which ions compete is further indicated by a number of other results which will be discussed more fully elsewhere: (*a*) Competition affects not only the initial inward movement of ions (cf. Table 1) but also their rate of exchange when the tissues are transferred to unlabelled solutions. (*b*) When equivalent concentrations of rubidium and cæsium are administered for five minutes it is found that rubidium is more effective than cæsium in inhibiting the entry of the other ion—a result contrary to that obtained with inert exchange systems.

It is concluded, therefore, that the process of ionic accumulation is considerably more complex than that envisaged by Jacobsen and Overstreet[5], who postulated a single exchange step for ions of either sign whereby they are bound to carrier molecules which transfer them across the cytoplasm. No evidence as yet available, however, appears to conflict with the view that reactions of the type they envisage may occur after the initial entry of ions by exchange into the tissues. For reasons discussed elsewhere[6], this hypothesis is attractive, but it is, as yet, unsupported either by the identification of the carrier or by evidence as to the manner whereby ions are bound on the carrier. Epstein[4] has endeavoured to examine the latter question by a kinetic study of the interaction of ions for entry into tissues. If the conclusions here presented are correct, his interpretation is unwarranted since ions interact for sites unconnected with the mechanism which is responsible for their transference across the cytoplasm. Moreover, the manner in which he analysed his results appears open to question. He employed the procedure developed by Lineweaver and Burk[8] for enzymatic studies. For this procedure to be applicable to salt uptake, a linear relationship must exist between the reciprocal of the rate of absorption and the reciprocal of the external concentration. Epstein demonstrated the linearity of this relationship for the absorption of rubidium from solutions of concentrations 2–50 milli-equivalents per litre. In the present work, however, a concentration-range extending down to 0·1 milli-equivalents per litre was used with carrot disks under similar conditions and it was found that the relationship was not linear over this wider concentration range. The results of an experiment using cæsium at concentrations 0·1–12·8 milli-equivalents per litre are shown in Fig. 1. Similar results were obtained with rubidium. It is apparent from Fig. 1 that a linear relationship might have been inferred from the results which lie within the range employed by Epstein. Thus it must be concluded that theoretical interpretations based on such data are likely to be misleading until the steps in the overall process of ionic absorption are more fully elucidated.

Table 3. The Absorption and Distribution of Rubidium in Young Barley Plants provided with potassium prior to, or simultaneously with, Rubidium. Duration of Experiment, 24 Hours

	Pretreated for 48 hr. with $0{\cdot}5 \times 10^{-3}$ M potassium		Not pretreated with potassium		S.D. ($P = 0{\cdot}05$)
	Concentration of rubidium $M \times 10^{-3}$				
	1	10	1	10	
Rubidium absorbed mgm./plant					
K absent from external solution	1·33	2·33	5·20	7·29	*0·086*
	1·122	*1·366*	*1·714*	*1·866*	
2×10^{-3} M K present in external solution	0·324	2·35	1·20	6·15	
	0·510	*1·370*	*1·067*	*1·788*	
% absorbed rubidium in shoots					
K absent from external solution	43·87	44·04	55·69	63·66	4·63
2×10^{-3} M K present in external solution	36·90	40·79	52·33	66·82	

When a logarithmic transformation was necessary for statistical analysis the transformed values are shown in italics.

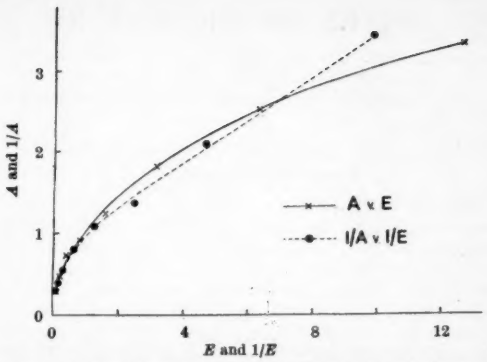


Fig. 1. Relationship between external concentration and absorption of cæsium by carrot disks in 4 hr. at 25° C. *A*, Cæsium absorbed in milligrams/20 disks; *E*, external concentration of cæsium in milli-equivalents/litre. The relationships between these quantities and between their reciprocals are shown

We wish to acknowledge our indebtedness to the Agricultural Research Council and to the Ministry of Supply for support at different stages of this work.

[Nov. 29.

[1] Butler, G. W., *Physiol. Plant.*, **6**, 617 (1953).
[2] Hope, A. B., *Aust. J. Biol. Sci.*, **6**, 396 (1953). Hope, A. B., and Stevens, P. G., *Aust. J. Sci. Res.*, B, **5**, 335 (1952).
[3] Broyer, T. C., "Mineral Nutrition of Plants", 87 (Wisconsin, 1951).
[4] Epstein, E., Proc. Oak Ridge Summer Symposium, **4** (1952); *Nature*, **171**, 83 (1953). Epstein, E., and Hagen, C. E., *Plant Physiol.*, **27**, 467 (1952).
[5] Jacobsen, L., and Overstreet, R., *Amer. J. Bot.*, **34**, 415 (1947).
[6] Lundegårdh, H., *Physiol. Plant.*, **3**, 103 (1950).
[7] van der Honert, T. H., *Versl. Vergaal. Vereen. Profsta. Parsoneel.*, **16**, 86 (1936).
[8] Lineweaver, H., and Burk, D., *J. Amer. Chem. Soc.*, **56**, 658 (1934).
[9] Russell, R. Scott, Soc. Exp. Biol., Symposium, **8**, 343 (1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Analgesic and Antipyretic Activities of 4-Hydroxy*iso*phthalic Acid

4-Hydroxy*iso*phthalic acid is a by-product of the manufacture of salicylic acid by the Kolbe–Schmitt reaction and has been found to be a major constituent of the 'brown dust' residues from the sublimation process for the purification of salicylic acid[1]. Analysis of a typical sample of 'brown dust' showed it to contain 10 per cent of salicylic, 82 per cent of 4-hydroxy-*iso*phthalic and 3 per cent of 2-hydroxy*iso*phthalic acids, together with some inorganic material. From this source there is thus potentially available a considerable quantity of 4-hydroxy*iso*phthalic acid, the chemistry of which is being investigated as part of a research programme on the Kolbe–Schmitt reaction at the Chemical Research Laboratory[2]. From a consideration of its structural similarity to salicylic acid, it was suggested at the Chemical Research Laboratory that 4-hydroxy*iso*phthalic acid might also possess similar pharmacological properties. Accordingly, in February 1954, a pharmacological investigation was initiated at Ware and, since the findings were favourable, biochemical studies were also undertaken.

In the initial experiments, drugs were administered by the intraperitoneal route, aspirin and phthalic acid derivatives being suspended in 5 per cent gum acacia. In analgesic tests, a simplified form of the analgesiometer of Green, Young and Godfrey[3] was used, which measures responses in terms of the pressure, applied to the tip of the tail, required to elicit a squeak from a young rat. This method showed that 4-hydroxy*iso*phthalic acid undoubtedly possesses analgesic properties, its median effective dose being 303 (limits 261–353) mgm. per kgm. In comparative tests it exhibited 4·1 (limits 3·2–5·5) per cent of the activity of codeine. The median lethal dose (*LD*50) for young rats was 1,071 (limits 968–1,185) mgm. per kgm., and a dose of 600 mgm. per kgm. was tolerated by all eighty-seven rats which received it. Comparison of the *LD*50 of 4-hydroxy-*iso*phthalic acid with the corresponding published figures for codeine[4] indicates that it possesses about 10 per cent of the toxicity of codeine. Compared with 4-hydroxy*iso*phthalic acid, aspirin was both more toxic and less effective. The *LD*50 was 541 (limits 485–603) mgm. per kgm., and a dose of 300 mgm. per kgm., which was tolerated by all rats, failed to show any analgesic effect, although higher doses appeared to do so.

In comparative tests of antipyretic activity in rabbits, it was found that 4-hydroxy*iso*phthalic acid was about as effective as aspirin in counteracting fevers caused by a preparation of pyrogen from *Proteus vulgaris*.

Since 4-hydroxy*iso*phthalic acid promised to have clinical value of a type similar to, but greater than, aspirin, a chronic toxicity test was carried out by administering the drug at 0·5 and 1·0 per cent in the diet to mice for a period of fourteen weeks. In this experiment, it exhibited very low toxicity, of the same order as that of aspirin, which was used for reference.

Analgesic tests were also performed with 2-hydroxy-*iso*phthalic, phthalic, *tere*phthalic and *iso*phthalic acids. The 2-hydroxy acid was about equipotent to the 4-hydroxy, while the unsubstituted acids showed slight activity.

Preliminary investigations on the excretion of 4-hydroxy*iso*phthalic acid by rats showed that within 24 hr. about 40 per cent of a 10-mgm. dose given by stomach tube was excreted unchanged in the urine and about 25 per cent in the fæces. The method of estimation was based on the reddish-purple colour formed when the acid is allowed to react with ferric nitrate. Acid hydrolysis failed to increase the amount of free 4-hydroxy*iso*phthalic acid, suggesting the absence of certain conjugated forms from the urine, while the absence of other possible metabolites, such as salicylic, *p*-hydroxybenzoic and gentisic acids, was demonstrated by means of paper electrophoresis.

Clinical trials to investigate the possible therapeutic applications of these findings are in progress.

The 'brown dust' was kindly supplied by Monsanto Chemicals, Ltd. We wish to thank the directors of Allen and Hanburys, Ltd., and the director of the Chemical Research Laboratory, Teddington, for permission to publish this work.

G. B. Chesher
H. O. J. Collier
F. A. Robinson
E. P. Taylor
Research Division, Allen and Hanburys, Ltd., Ware, Herts.

S. E. Hunt
J. Idris Jones
A. S. Lindsey
Chemical Research Laboratory (Department of Scientific and Industrial Research), Teddington, Middlesex.

Nov. 15.

[1] Report of Chemistry Research Board, 66–67 (1952); 36 (1953). (London: H.M.S.O.)
[2] Hales, J. L., Jones, J. Idris, and Lindsey, A. S., *J. Chem. Soc.*, 3145 (1954).
[3] Green, A. F., Young, P. A., and Godfrey, E. I., *Brit. J. Pharmacol.*, **5**, 572 (1951).
[4] Poe, C. F., Strong, J. G., and Witt, N. F., *J. Pharmacol.*, **61**, 62 (1937).

Imidazole Complexes of Myoglobin and the Position of the Hæm Group

We have prepared complexes of imidazole, 1-methyl imidazole and 4-methyl imidazole with various species of myoglobin, and crystallized them in forms previously described[1]; the X-ray diffraction patterns of the crystals were then compared with those obtained from corresponding forms of met-myoglobin crystals. The results, which were similar for all three imidazoles, are summarized in Table 1. (In each case a large excess of imidazole was used: without this precaution combination is always incomplete.)

Table 1

Species	Form		*a*	*b*	*c*	*β*	Intensities
Sperm-whale (ammon. sulphate)	Met-	*A*	64·6 A.	31·1 A.	34·8 A.	105·5°	Scarcely changed
	Imid-	*A*	64·4	30·7	34·7	105·5°	
Sperm-whale (phosphate)	Met-	*B*	48·9	40·2	79·3		Considerable changes
	Imid-	*B*	48·8	40·3	78·5		
Gentoo penguin (ammon. sulphate)	Met-		(no crystals formed)				
	Imid-	*I*	94·5	38·3	43·5		
Gentoo penguin (phosphate)	Met-	*G*	48·3	80·2	78·5		
	Imid-	*H*	106·4	39·1	45·3		

Three types of behaviour have been observed. (*a*) In sperm-whale monoclinic crystals (type *A*), the imidazole derivative is nearly isomorphous with the metmyoglobin. The cell dimensions are virtually unaltered, if anything slightly decreased; the intensities are scarcely changed, the differences being of the same order of magnitude as those between carbonmonoxy- and met-myoglobin crystals. (*b*) In sperm-whale orthorhombic crystals (type *B*), the imidazole derivative has again nearly the same cell dimensions as the metmyoglobin; but the intensities are very substantially changed, and are appreciably different in the different imidazole derivatives. (*c*) In gentoo penguin myoglobin, either grown in ammonium sulphate or in phosphate, the addition of an imidazole group produces a radical change in crystal packing. In ammonium sulphate the metmyoglobin will not crystallize at all, whereas the imidazole derivative gives orthorhombic crystals of type I ($P2_12_12_1$, 4 mol./cell): in phosphate the metmyoglobin gives the face-centred type *G* ($C222_1$, 8 mol./cell), while the imidazole derivative gives the orthorhombic type *H* ($P2_12_12_1$, 4 mol./cell).

These results give some indications about the location of the hæm group in myoglobin. Broadly, we can imagine three main types of site for the group: (i) embedded deeply inside the molecule; (ii) on the side of a wide cleft or groove; and (iii) on the surface. In case (i) the attachment of a substantial group such as methyl-imidazole (which is a roughly circular disk of dimensions about 7 A. × 3·7 A., by no means negligible in comparison with the molecule of myoglobin itself which, if spherical, would have a diameter of about 32 A.) should change the dimensions of the molecule and appreciably increase at least some of the cell dimensions in all the crystal forms; in case (ii) a group attached to the hæm would exert no steric effects at all and imidazole crystals would be isomorphous with metmyoglobin crystals in all forms. On the other hand, in case (iii) one would anticipate that in some forms of crystal the hæm group would be distant from points of contact between molecules, and no changes in structure would be produced by attachment of imidazole to it (as observed in sperm-whale monoclinic crystals); whereas in others the imidazole group attached to hæm would be near a point of contact and would cause appreciable distortions in packing (as in sperm-whale orthorhombic crystals) or would even impose a completely new type of packing (as in penguin crystals).

Hence it appears to us very probable that the hæm group is located on the surface of the myoglobin, though it must be realized that any conclusion is bound to be tentative, partly because it is easy to imagine various configurations of the molecule intermediate between the three extremes defined above, partly because it is not certain (though it is very likely) that the molecule of penguin myoglobin has a structure similar to that of sperm-whale myoglobin. Finally, it may be noted that these surmises are not directly applicable to hæmoglobin, about the hæm positions in which differing conclusions have been drawn by different workers (see, for example, St. George and Pauling[2] and Keilin[3]); but they would be relevant if, as has more than once been suggested, the hæmoglobin molecule is made up of four subunits each resembling that of myoglobin (in architecture, not amino-acid composition). In that case, there would be no necessary inconsistency even if the hæm groups of hæmoglobin were proved to be 'inside', since the arrangement of the sub-units (each having its hæm 'outside') might easily lead to such a configuration; equally, no difficulty would arise if the hæm groups of hæmoglobin were shown to be 'outside'.

J. C. Kendrew
R. G. Parrish*
Medical Research Council
Unit for the Study of the Molecular Structure
of Biological Systems,
Cavendish Laboratory,
Cambridge.
Nov. 29.

* Merck Post-Doctoral Fellow of the U.S. National Research Council at the Cavendish Laboratory, Cambridge, 1952–54. Present address: Department of Physics, University of Michigan, Ann Arbor, Michigan.

[1] Kendrew, J. C., Parrish, R. G., Marrack, J. R., and Orlans, E. S., *Nature*, 174, 946 (1954).
[2] St. George, R. C. C., and Pauling, L., *Science*, 114, 629 (1951).
[3] Keilin, D., *Nature*, 171, 922 (1953).

Acetylation of Sulphanilamide in Plants

In animals, sulphonamides are detoxified most commonly by acetylation of the free amino-group, a process usually localized in the liver[1]. In the course of a study of the movement of sulphanilamide in plants[2], it was found that part of the free drug became bound within the plant and that the change could be reversed by acid hydrolysis. The possibility that this change in the drug was due to acetylation has been investigated.

Broad bean plants (*Vicia faba* L.) were grown for thirty-three days with their roots immersed in an aqueous solution of sulphanilamide (100 μgm./ml.). The roots, stems and leaves of treated plants were sampled separately, killed in ether and the sap expressed[3]. 0·2-ml. aliquots of sap from treated plants were run on paper chromatograms (Whatman No. 1) in an *n*-butanol – acetic acid – water solvent system[4] (50–15–35 or 40–10–50) or an *n*-butanol – ammonia – water system[5] (40–10–50). In addition, sulphanilamide and acetyl sulphanilamide were added to the sap of untreated plants to give a final concentration of 50 μgm./ml. of the drug, and 0·2-ml. aliquots of these control solutions were run as markers. Chromatograms were run for 16 hr. at 25° C. and sulphanilamide spots were located by diazotization with a spray of 0·1 per cent sodium nitrite in glacial acetic acid and the addition of a coupling component, N-β-sulphatoethyl-*m*-toluidine[6] in 95 per cent butanol. The chromatograms showed the presence of sulphanilamide in the leaves of treated plants; but there was little free drug in the roots although bound drug could be revealed by hydrolysis. After the first diazotization and coupling, the papers were cut into sections 1 cm. × 2 cm. from the sulphanilamide spots to the solvent front, and each section was hydrolysed by boiling for 15 min. in 2 ml. *N* hydrochloric acid, the acid neutralized and the diazo colour produced. By measuring the optical density of the colour of these solutions in a spectrophotometer at 510 mμ, the position of acetyl sulphanilamide on the paper could be determined. Chromatograms of sap from treated plants showed spots with the same R_F value as acetyl sulphanilamide, indicating that acetylation of sulphanilamide occurs in plant tissue as in animal. There were greater concentrations of the acetyl compound in roots than in stems or leaves.

R_F values of sulphanilamide and acetyl sulphanilamide dissolved in various media were compared.

Table 1. Comparison of R_F Values of Sulphanilamide and Acetyl Sulphanilamide in Various Media

Medium	Solvent system			
	Butanol – acetic acid – water		Butanol – ammonia – water	
	Sulphanilamide	Acetyl sulph.	Sulphanilamide	Acetyl sulph.
Water	0·64	0·80	0·59	0·79
Sap from treated plants	0·47	0·71	0·54	0·73
Sap from untreated plants with drug added	0·57	0·77	0·57	0·77

Differences of *p*H over the range 4·5–13·0 produced a change of only 0·01 in the R_F value; but the drugs in plant sap had lower R_F values than in water. This effect became more pronounced with longer exposure in plant sap, particularly with sap from treated plants (Table 1). The R_F value of sulphanilamide or acetyl sulphanilamide added to plant sap could be lowered to the same extent as that for the drug in sap from treated plants if an interval of 24 hr. was allowed between adding the drug and running the chromatogram. The butanol – ammonia – water system gave better separation and less tailing with the drugs in expressed sap than the butanol – acetic acid – water system.

Acetylation in plants is being studied in further detail, but this preliminary note is published to direct attention to a process which may be a common phenomenon in plant tissues.

D. Rudd Jones
Jenifer Wignall

Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
Welwyn, Herts.
Oct. 12.

[1] Harris, J. S., and Klein, J. R., *Proc. Soc. Exp. Biol. N.Y.*, **38**, 78 (1938).
[2] Crowdy, S. H., and Jones, D. Rudd (unpublished work).
[3] Crowdy, S. H., and Pramer, D., *Ann. Bot. N.S.* (in the press).
[4] Steel, A. E., *Nature*, **168**, 877 (1951).
[5] Longenecker, W. H., *Anal. Chem.*, **21**, 1402 (1949).
[6] Rose, F. L., and Bevan, H. G. L., *Biochem. J.*, **38**, 116 (1944).

Rat Liver Xanthine Oxidase in Carbon Tetrachloride Poisoning

During the course of experiments dealing with the effect of some hepatotoxic drugs on rat liver xanthine oxidase, it was found that this enzyme is activated when carbon tetrachloride is administered in a single necrogenic dosage. The present communication presents results obtained in normal young rats injected subcutaneously with 0·1 ml./100 gm. body-weight.

Male Wistar white rats weighing 90–195 gm. on a well-balanced diet were used throughout this study. The animals were killed by decapitation 3–48 hr. after the administration of the drug and food was withdrawn during the experimental period. Normal controls showed that the injection of 0·1 ml./100 gm. body-weight caused an acute congestion of the liver with a microscopic picture of focal necrosis characteristic of carbon tetrachloride injury, but no death occurred.

Liver xanthine oxidase was determined by the method of Axelrod and Elvehjem from the oxygen uptake in a conventional Warburg manometer apparatus at 37° C., using xanthine as a substrate and air as the gas phase[1]. The high endogenous respiration of liver homogenates does not permit the accurate assay of xanthine oxidase, particularly in cases where the activity of this enzyme is low. The incubation of the homogenate at 37° C. for 40 min. before tipping the substrate partly suppressed the endogenous respiration. Recently, Dhungat and Sreenivasan[2] substituted a phosphate buffer of *p*H 7·4 for a pyrophosphate buffer of *p*H 8·6 in the determination of xanthine oxidase, based on the observation of Dixon and Elliott[3] that pyrophosphate inhibits endogenous respiration. Therefore, this important improvement of the original method of Axelrod and Elvehjem was used in our experiments.

Table 1. Liver Xanthine Oxidase and Xanthine Dehydrogenase of Rats Intoxicated with Carbon Tetrachloride and Previously Treated with Sodium Xanthine and Vitamin B_{12}

Conditions	Xanthine oxidase (c.mm. oxygen/gm. dry-weight in 60 min.) Average values	Xanthine dehydrogenase (μgm. formazan/mgm. dry-weight) Average values
Normal, starved 24 hr.	1,223	1·6
Normal, starved 48 hr.	921	1·4
CCl_4 24 hr.*	1,483	1·6
CCl_4 24 hr.†	1,771	0·9
CCl_4 48 hr.†	1,325	1·0
Sodium xanthine starved 24 hr.	1,295	0·7
Sodium xanthine + carbon tetrachloride 24 hr.†	883	0·5
Vitamin B_{12} normal diet	1,786	1·6
Vitamin B_{12} + carbon tetrachloride 24 hr.†	2,460	1·9
Vitamin B_{12} + carbon tetrachloride 48 hr.†	1,457	2·0

* Rats starved 24 hr., injected with carbon tetrachloride and killed 3 hr. later.
† Time of starvation after the administration of carbon tetrachloride.

The xanthine dehydrogenase activity in rat liver was also measured using the anaerobic reduction of the colourless dye triphenyltetrazolium chloride in a Thunberg vacuum tube, and the red formazan extracted with toluol or with petroleum ether (ligroin) when the livers were rich in lipids[4]. The results for xanthine oxidase activity were expressed in c.mm. of oxygen consumed in 60 min. per gm. dry-weight and for xanthine dehydrogenase activity in μgm. formazan per mgm. dry weight.

Normal well-fed rats gave values for xanthine oxidase of 1,638 ± 168 c.mm. oxygen and rats starved for 24 hr. and 48 hr. values of 1,223 ± 32 c.mm. and 921 ± 177 c.mm. respectively. Starved rats injected with carbon tetrachloride showed increased values which were statistically significant. When

Table 2. Oxidation of Xanthine by Liver Homogenates in Normal Rats and Rats treated with Carbon Tetrachloride, measured colorimetrically

Conditions	No. of rats	Average weight (gm.)	μgm. xanthine/gm. liver		
			Incubation time (min.)		
			0	120	180
Normal	7	67	580	436	150
Carbon tetrachloride 24 hr.*	7	72	314	8	0
,, ,, 24 hr.*	7	134	455	22	0
,, ,, 48 hr.*	3	195	476	73	72
,, ,, + vitamin B_{12} 24 hr.†	3	229	576	0	0
Carbon tetrachloride + vitamin B_{12} 24 hr.†	2	67	700	0	0
Carbon tetrachloride + vitamin B_{12} 48 hr.†	2	60	810	0	0

* Time of starvation after the injection of carbon tetrachloride (0·1 ml./100 gm. body-weight).
† Vitamin B_{12} (15 μgm. 24 hr. before the administration of carbon tetrachloride).

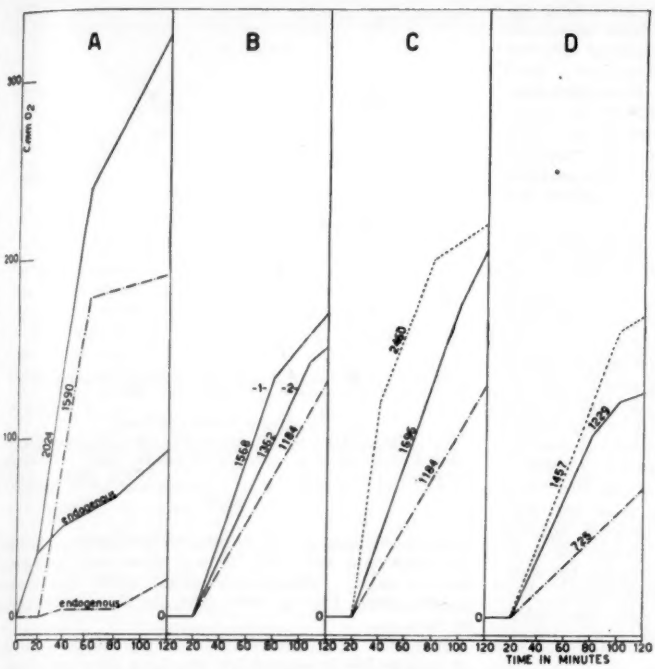


Fig. 1. Activation of rat liver xanthine oxidase.

(*A*) *in vitro* activation: ——·——·——, normal; ————, same homogenate added with carbon tetrachloride (0·1 ml./10 ml.).
(*B*) *in vitro* and *in vivo* activation: — — — —, liver of normal rat starved for 24 hr.; -1-·-1-, *in vitro* addition of carbon tetrachloride; -2-·-2-, xanthine oxidase rat starved 24 hr., injected with carbon tetrachloride and killed 3 hr. later.
(*C*) *in vivo* activation: ——·——·——, normal rat starved 24 hr.; ————, rat starved 24 hr. and injected with carbon tetrachloride; ·····, rat injected with vitamin B_{12}, and after 24 hr. receiving carbon tetrachloride and then starved for 24 hr.
(*D*) *in vivo* activation: ——·——·——, normal rat starved 48 hr.; ————, rat starved 48 hr. and injected with carbon tetrachloride; ·····, the same as in (*C*) but starved 48 hr.

(Numbers on graph represent values of xanthine oxidase in c.mm. oxygen/gm. dry-weight/60 min.)

starved for 24 hr. and killed 3 hr. after administration of carbon tetrachloride, increased values of xanthine oxidase were obtained ($t = 3{\cdot}17$, $P < 2$ per cent), and for those killed after 24 hr. and 48 hr. the values had still greater significance ($t = 5{\cdot}9$, $P < 1$ per cent, and $t = 3{\cdot}51$; $P < 1$ per cent).

Some typical results are shown in Fig. 1 and Table 1. The *in vitro* addition of carbon tetrachloride (0·1 ml. to 10 ml. of the liver homogenate) activated the xanthine oxidase as shown in Fig. 1, *A* and *B*. It is interesting to note that the xanthine dehydrogenase activity decreased in the liver of the intoxicated rats (Table 1).

The activation of xanthine oxidase in rats treated with carbon tetrachloride was shown to be due to the oxidation of the substrate, as confirmed by simultaneous experiments in which the xanthine was measured colorimetrically after 120–180 min. of the incubation of the whole system according to the method of Litwak *et al.*[5]. These results are summarized in Table 2. The livers of the rats injected with carbon tetrachloride and killed after 48 hr. showed a smaller increase of activity than those killed after 24 hr., a fact possibly related to the regeneration of the liver during this time.

It is known that sodium xanthine and liver extracts containing xanthine are able to protect the rat liver against the necrosis occurring in carbon tetrachloride poisoning[6]. Experiments were carried out to find the effect of sodium xanthine in normal rats and rats treated with carbon tetrachloride as well as of vitamin B_{12} (cobalamin), which was claimed by Popper *et al.*[7] to prevent liver necrosis. Sodium xanthine (100 mgm./100 gm. body-weight) had no effect on liver xanthine oxidase in normal rats, but inhibited its enzyme activity of about 50 per cent in rats injected with carbon tetrachloride. However, xanthine dehydrogenase decreased in normal as in poisoned rats (Table 1). Vitamin B_{12}, kindly supplied by Merck and Co., Rahway, N.J., injected at 15 μgm./100 gm. body-weight, was without effect on the xanthine oxidase and dehydrogenase activities of normal rats; but both these activities were much increased in rats treated with carbon tetrachloride (Table 1 and Fig. 1, *C* and *D*).

The results reported here indicate that liver xanthine oxidase is activated and xanthine dehydrogenase partly inhibited by carbon tetrachloride when injected in a single dose. Sodium xanthine, which protects the rat against liver injury in carbon tetrachloride poisoning, inhibits the oxidase and dehydrogenase activities of this enzyme in intoxicated animals. However, vitamin B_{12} increases these activities notwithstanding its protective effect in this experimental intoxication.

Gilberto G. Villela
Emilio Mitidieri

Division of Biochemistry,
Oswaldo Cruz Institute,
Rio de Janeiro. Sept. 24.

[1] Axelrod, A. E., and Elvehjem, C. A., *J. Biol. Chem.*, **140**, 725 (1941).
[2] Dhungat, S. B., and Sreenivasan, A., *J. Biol. Chem.*, **208**, 845 (1954).
[3] Dixon, M., and Elliott, K. A. C., *Biochem. J.*, **23**, 812 (1929).
[4] Villela, G. G., *Rev. Bras. Biol.*, [**14**, 455 (1954)].
[5] Litwak, J. W., Bothwell, J. W., Williams, jun., J. N., and Elvehjem, C. A., *J. Biol. Chem.*, **200**, 303 (1953).
[6] Forbes, J. C., and Neale, R. C., *Proc. Soc. Exp. Biol. Med.*, **34**, 319 (1936).
[7] Popper, H., Koch-Weser, D., and Szanto, P. B., *Proc. Soc. Exp. Biol. Med.*, **71**, 688 (1949).

Infectivity and Nucleic Acid Content of Influenza Virus

Much of the present belief that the genetic properties of viruses are carried by their nucleic acid moieties arises from recent work with plant and bacterial viruses. Infection of the host cell has been shown to result in the formation of particles which, though closely related to the accompanying virus components, are non-infectious. Analyses indicate that the non-infectious material contains little or none of the nucleic acid present in the infectious particle[1].

Methods have been described for producing influenza virus preparations which differ from 'standard' virus in possessing high hæmagglutinating activity but low infectivity[2]. Such preparations have been termed 'incomplete', the degree of incompleteness being indicated by the ratio of infectivity to hæmagglutinin, I/A. It seemed worth while to see if any correlation existed between the degree of incompleteness and the nucleic acid content of the virus particle. The preliminary results of such an investigation are reported here.

All experiments were carried out with the *PR*8 strains of influenza virus. Infected allantoic fluids, harvested 30–42 hr. after inoculation with virus diluted to $ID_{50} = 10^{-6}$, served as a source of standard virus, whereas incomplete virus was prepared from infected allantoic fluid harvested after two or three serial passages (each 12–16 hr.) of undiluted (initially $ID_{50} = 10^{-3}$) inoculum[2,3]. Hæmagglutinin and infectivity titres[4] were determined on the freshly harvested fluids. The virus was purified by adsorption on to, and elution from, human red cells followed by two cycles of differential centrifugation (45,000 *g*, 30 min.; 6,000 *g*, 10 min.). Yields of purified virus varied from 20 to 60 per cent. The virus was precipitated with trichloracetic acid, dialysed against distilled water and dried from the frozen state *in vacuo*. The degree of purity was estimated by comparing the ratio hæmagglutinin units/mgm. dry-weight. Values given by standard and incomplete virus preparations fell within the same range, $6–12 \times 10^4$.

It has recently been found that influenza virus contains only ribonucleic acid in significant amounts, no appreciable amount of deoxyribonucleic acid being present. The ribonucleic acid content could be conveniently estimated by measuring the ultra-violet absorption at 260 mμ of a hot 10 per cent sodium chloride extract of defatted virus. Values of approximately 0·8 per cent for standard virus preparations were obtained[4].

In Fig. 1 are plotted nucleic acid values of purified virus prepared from infected allantoic fluids the I/A ratios of which varied from $10^{6.5}$ to $10^{3.2}$. There is a considerable spread in these ratios for the different experimental groups, due largely to seasonal variations in the eggs. Also, virus preparations having similar I/A values show an appreciable range of ribonucleic acid values, and this appears to be partly due to varying lipid content. Despite these variations, it is clear that reduction in the I/A ratio is accompanied by a progressive decrease in the nucleic acid content, the latter being expressed as the percentage per mgm. dry-weight of virus. As originally reported[2], however, incomplete virus has a lower sedimentation constant than standard virus, and recent work[5] indicates that this may be due to the high lipid content (and hence lower density) of the former. Thus, expressing the above values on a weight of ribonucleic acid per virus particle basis would increase the difference between the ribonucleic acid content of standard and incomplete virus. The magnitude of the change must await the results of virus particle counts.

It was thought possible that some indication of the specificity of the missing components in incomplete virus could be obtained by comparing the gross proportion of bases in preparations of different I/A ratios. When analysed by chromatography following hydrolysis with N hydrochloric acid[6], the nucleic acid isolated from the sodium chloride extract gave

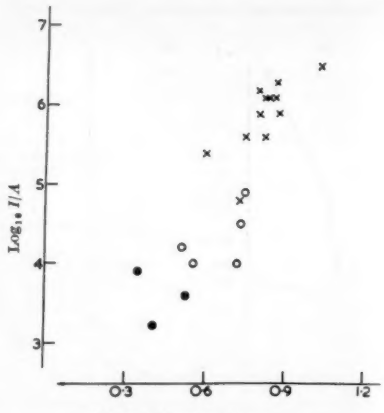


Fig. 1. Relationship between the infectivity/hæmagglutinin ratio and the nucleic acid content of influenza virus. ×, Single passage (0·05 ml., $ID_{50} = 10^{-4}$); ○, double passage (each 1·0 ml. undiluted fluid); ●, triple passage (each 1·0 ml. undiluted fluid)

spots coinciding in R_F values with adenine, guanine, cytidylic acid and uridylic acid obtained from yeast nucleic acid. Six preparations with I/A values ranging from $10^{6.5}$ to $10^{4.3}$ gave identical proportions of base.

It seems not unreasonable to postulate that loss of infectivity is caused by the lack of a small proportion only of genetic units corresponding to the observed decrease in nucleic acid content. Sufficient nucleic acid is present in particles which are 99 per cent incomplete to suggest that they still contain genetic material which could contribute to the 'genetic pool' in recombination experiments, and such has been found to be the case[7]. However, the present limited evidence does not indicate whether the decrease in infectivity is due to a random or orderly loss of genetic units.

G. L. Ada
Beverley T. Perry
Walter and Eliza Hall Institute of Medical Research, Melbourne.
Sept. 9.

[1] Markham, R., Farad. Soc. Discuss., No. 11, 221 (1951). Commoner, B., Yamada, M., Rodenberg, S. G., Wang, T.-Y., and Basler, E., *Science*, **118**, 529 (1953). See review, "The Properties of Bacteriophages", by Epstein, H. T., in "Advances in Virus Research", p. 1 (Academic Press, Inc., N.Y., 1953).
[2] von Magnus, P., *Arkiv Kemi.* ....., *Swed. Acad. Sci.*, **24** B, No. 7 (1946).
[3] Fazekas de St. Groth, S., and Graham, D. M., *Brit. J. Exp. Path.*, **35**, 60 (1954).
[4] Ada, G. L., and Perry, B. T., *Aust. J. Exp. Biol.*, [**32**, 453 (1954)].
[5] Uhler, M., and Gard, Sven, *Nature*, **173**, 1041 (1954).
[6] Smith, J. D., and Markham, R., *Biochem. J.*, **46**, 509 (1950).
[7] Burnet, F. M., and Lind, P. E., *Aust. J. Exp. Biol.* (in the press).

Total Sugar and Nitrogen Contents of Jute Plants, with Special Reference to the Flowering Stage

The relative increase of carbohydrate over nitrogen has been regarded as a sign of a shift from the vegetative to the reproductive state in plants. The ratio of soluble sugar and nitrogen in normal and in photoperiodically induced plants was determined in jute, which has been found to be a short-day plant[1]. Total sugar and total nitrogen calculated as percent-

Table 1. *Corchorus capsularis* AND *C. olitorius* SOWN ON APRIL 20, 1954

C. capsularis					*C. olitorius*				
Treatment	Sampling date in days after sowing	% Sugar (*A*)	% Nitrogen (*B*)	*A*/*B*	Treatment	Sampling date in days after sowing	% Sugar (*A*)	% Nitrogen (*B*)	*A*/*B*
10 hr. (in flower)	29	0·879	1·939	0·04533	10 hr. (in flower)	21	0·4155	2·215	0·1875
Control (vegetative)	29	0·0245	5·0225	0·004877	Control (vegetative)	21	0·2205	2·044	0·1079
					,, (in flower)	117	0·391	2·044	0·1914

age of dry-weight of the whole plant are given in the tables as a mean of four plants.

The sugar–nitrogen ratio is comparatively higher in the plants which are induced to flower early. The work of Parker and Borthwick[2] and Murneek[3] on soybeans gives similar results.

The sugar and nitrogen contents of plants before, at, and after flowering were determined at intervals of five days in *C. olitorius* sown on March 15. It is known[4] that this species when sown in March flowers very early under natural conditions. The results are given in Table 2.

Table 2. *C. olitorius* SOWN ON MARCH 15, 1954

Date of sampling	% Sugar	% Nitrogen	Sugar/nitrogen
26.3.54	11·046	3·65	3·026
31.3.54	2·5	4·2203	0·5978
5.4.54 (Flowering)	0·2763	0·7781	0·355
10.4.54	4·6135	6·244	0·7393
15.4.54	1·614	1·203	1·342

Both the sugar and nitrogen contents are found to fall considerably at the flowering stage, but rise again after the date of first initiation of flowers.

Analyses of plants sown in the normal season and induced photoperiodically to flower early, at regular intervals before and after flowering, will be of interest. For a more complete knowledge of the relationship, determinations of total carbohydrates including starch will be necessary.

SUMITRA TALUKDAR

Botanical Laboratory,
Presidency College,
Calcutta.
Sept. 20.

[1] Sen Gupta, J. C., and Sen, ... K., *J. Ind. Agric. Sci.*, **14**, 196 (1944).
[2] Parker, M. W., and Borthwick, H. A., *Bot. Gaz.*, **100**, 651 (1939).
[3] Murneek, A. E., "Nutrition and Metabolism as related to Photoperiodism" (Chronica Botanica Co., Waltham, Mass., 1948).
[4] Sen Gupta, J. C., and Sen, N. K., *J. Ind. Bot. Soc.*, **26**, 41 (1947).

Cortical Zonation and Survival of Chromaffin Cells in Adrenal Autografts

IN the earlier investigations relating to the transplantation of the adrenal gland, which were summarized by Biedl[1], success depended largely upon the preservation of the original blood supply of the gland, and in consequence the organ had to remain in close proximity to its original bed. The later work of Ingle and Higgins[2] showed that, when the gland is transferred to distant sites, all except a few cells of the glomerulosa degenerate and that these surviving cells then proliferate and produce a mass of cortical tissue. Greep and Deane[3] have shown that the subcapsular cells of the enucleated rat adrenal gland are capable of reforming a complete gland (less medulla) in which the three descriptive zones—glomerulosa, fasciculata and reticularis—can be recognized.

In the present work, a series of twenty adult rabbits and six adult rats have been subjected to a left adrenalectomy. The gland is then divided into two parts by a cut at right angles to its long axis and a slice 0·5–1 mm. in thickness removed from the cut face with a razor-blade. The medulla and cortex can be readily distinguished in such a slice by the translucency of the former and white opacity of the latter. The medulla and cortex are separated as accurately as possible along the cortico-medullary junction, washed in isotonic saline and the medullary portion inserted into the anterior chamber of the left eye.

In the rabbit, during the first two weeks, degenerative changes affect some phæochromocytes and some cortical cells—the latter are invariably present as the zona reticularis extends as a series of cords into the medulla and may reach the central vein. An occasional mitotic figure is observed in the cortical cells but not in the phæochromocytes. The graft is firmly attached to the iris after two weeks and vascularization is well marked by one month. In grafts aged two months and older, the cortical cells are more numerous than those of the medulla, and in two aged three and four months a typical peripheral glomerulosa (Fig. 1) has been observed which adjoins anastomosing cords of cortical cells; groups of phæochromocytes are scattered throughout the cortical tissue and give a strongly positive chromaffin reaction. Both cortex and medulla have been found in all specimens so far examined.

To date few rats have been killed for examination; but in those few both cortex and medulla exist in the grafts.

The source of the cortical cells is of importance. In taking the grafts, the knife blade was so far as possible kept on the cortico-medullary boundary, and hence the cells are mainly, if not entirely, derived

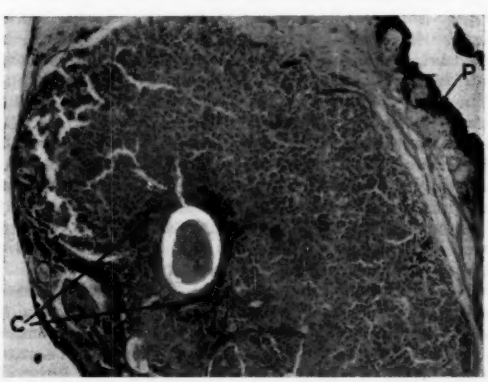


Fig. 1. Section through a four-month old graft of rabbit adrenal medulla and associated cortical cells. *P*, pigmented layer of iris; *C*, chromaffin cells; *S*, cortical cells

from the zona reticularis; although it is impossible to rule out entirely the presence of an occasional cell from the inner part of the fasciculata, these must at the most be few in number. The technique used and method of introduction into the eye precludes the possibility of transferring detached cells of the outer fasciculata or glomerulosa.

The proliferation of these inner-zone cortical cells is in keeping with the views of Blackman[4], Yoffey[5] and others, who regard the zona reticularis as a functionally active zone, while the formation of a peripheral glomerulosa in the absence of subcapsular cells supports the views of Jones and Wright[6], who consider that mechanical factors are responsible for the existence of this zone in the Eutherian adrenal cortex. Cortical cells in the graft multiply (as evidenced by mitotic figures), even when the right adrenal is intact; mitotic figures have not, however, been observed in chromaffin cells, and it appears that, although these elements persist, regeneration does not occur.

Rex E. Coupland

Department of Anatomy,
University, Leeds.
Oct. 5.

[1] Biedl, A., "The Internal Secretory Organs: their Physiology and Pathology" (John Bale, Sons and Danielsson, London, 1912).
[2] Ingle, D. J., and Higgins, G. M., *Endocrinol.*, **22**, 458 (1938).
[3] Greep, R. O., and Deane, H. W., *Endocrinol.*, **45**, 42 (1949).
[4] Blackman, S. S., *Johns Hopkins Hosp. Bull.*, **78**, 180 (1946).
[5] Yoffey, J. M., "The Suprarenal Cortex" (Butterworth, London, 1953).
[6] Jones, I. Chester, and Wright, A., *J. Endocrin.*, **10**, 266 (1954).

A Substance from Eel Serum producing Slow Contractions

Eel serum is well known for its hæmolytic and toxic properties[1]; but so far no report seems to have been published dealing with its effect on isolated organs. In the course of investigations into the effects and components of various animal venoms, it was noted that eel serum contained a substance which causes a delayed, slow contraction of the isolated guinea pig ileum and bears some resemblance to the substances producing slow contractions present in wasp venom[2] or appearing in cat plasma after intravenous injection of thalassine[3].

The material possessing this property proved so potent that in most cases it was found impossible to test its effect by applying undiluted serum to a sensitive preparation like the isolated guinea pig ileum suspended in magnesium-free Tyrode solution. When eel serum was diluted with 0·75 per cent saline to make a final dilution of 1 : 10 to 1 : 50, doses corresponding to as little as 0·002–0·01 ml. of the original serum contracted the gut suspended in an organ-bath of 18 ml. capacity. The contraction began after a typical latency of 10–45 sec. and reached its maximum after 60–90 sec. It persisted following treatment of the gut with atropine and neoantergane in doses sufficient to suppress strong acetylcholine or histamine contractions, and also remained unaffected after tryptamine desensitization[4]. In contrast to the substance present in wasp venom causing slow contraction, repeated doses of eel serum were progressively less active even if the interval between the contractions was extended to 15 min. and more; the gut then still responded to histamine in the usual manner.

If eel serum diluted with 0·75 per cent saline was dialysed against distilled water for up to 72 hr., no appreciable activity could be detected in the dialysate, whereas practically all of it could be recovered in the inner compartment, thus indicating that the active component is most probably a large molecule. The material producing the slow contraction was little affected by boiling diluted serum at neutral *p*H for 5 min. but was destroyed after a few minutes of this procedure in 0·1 *N* sodium hydroxide.

Undiluted eel serum caused a contraction of the isolated rat colon resembling that produced by serotonin in very small amounts. If all the activity detected by using the rat colon as a test organ is taken as representing serotonin, eel serum would contain about 0·03 μgm. serotonin per ml., a figure which is in good agreement with that published by Erspamer and Faustini[5] for extracted eel serum. No evidence for histamine occurring in appreciable amounts in eel serum was obtained. Small doses of eel serum produced vasoconstriction of long duration in the isolated rabbit ear perfused with Ringer–Locke solution at room temperature.

The nature of the material producing slow contraction is being further investigated and a detailed account of this work will be published elsewhere.

R. Jaques

Biological Department,
Ciba, Ltd., Basle.
Oct. 5.

[1] Phisalix, M., "Animaux venimeux et venins," **1** (Paris, 1922).
[2] Jaques, R., and Schachter, M., *Brit. J. Pharmacol.*, **9**, 53 (1954).
[3] Jaques, R., and Schachter, M., *Brit. J. Pharmacol.*, **9**, 49 (1954).
[4] Gaddum, J. F., *J. Physiol.*, **119**, 363 (1953).
[5] Erspamer, V., and Faustini, R., *Naturwiss.*, **40**, 317 (1953).

Spontaneous Microscopic Activity in Cardiac Muscle

When the heart stops beating, pulsations in individual cardiac muscle fibres continue. This can be observed by examining thin sections of living cardiac muscle under high-power magnification and transmitted light. The pulsations appear to be due to alternate relaxations and contractions of the fibres, with a concomitant change in the width of the striations. Under low-power magnification and by reflected light, the activity seen in the isolated mammalian heart is that of spontaneous minute contraction waves. Prinzmetal *et al.*[1] have noticed a similar though much faster activity in human and dog fibrillating auricles. It disappeared with the cessation of fibrillation.

These spontaneous minute contraction waves can be observed not only in non-beating hearts but also when the latter beat slowly *in situ*. This fact makes it uncertain if the pulsatile activity seen under high-power magnification and the spontaneous minute waves are one and the same phenomenon, and whether the pulsations are present only after cessation of the co-ordinated beat or whether they are a normal accompaniment of the heart-beat.

The spontaneous minute waves have been seen in all mammalian hearts so far examined, and their survival-times have been found to vary considerably, the longest seen so far being in rabbit auricles (stored at 4° C.) in which they could still be observed six days after isolation.

A study of the response of the spontaneous minute waves to changes in environment has shown that they are insensitive to relatively wide fluctuations of temperature.

The appearance of these waves to the eye is much like that of fibrillation in skeletal muscles; but the length of survival and the insensitivity to temperature fluctuations distinguish them from that phenomenon. It may be, however, that the phenomenon is essentially the same in both cases, but that its different characteristics in skeletal and cardiac muscle reflect rather intrinsic differences in these two types of striated muscle. It may be noted that Langley[2] found in cats that fibrillation may last half an hour after the death of the animal and thought this to be remarkably long.

Langley also noted that fibrillation in skeletal muscle is very sensitive to fluctuations of the normal temperature, cessation of fibrillatory activity being very quickly brought about by a fall from body to room temperature. Furthermore, if the spontaneous minute waves are due to fibrillation of the cardiac musculature, it is difficult to conceive how it is that they can be seen in the slowly beating heart, in which no apparent sign of fibrillation can be detected. On the other hand, like fibrillation, the spontaneous minute waves have been found to be sensitive to quinidine and procaine, both of which cause arrest of their activity. Urethane[3] was not found to prolong or increase their activity when drying of the surface film was prevented throughout the period of observation.

The following observations indicate that the spontaneous minute waves are present throughout the myocardium. When the heart is cut into small fragments, they continue their activity uninterruptedly. They are present in both ventricles and atria, and they can be observed on the walls of the chambers of the heart as well as on the outer surface. They are coarser and much more vigorous on the inner surfaces.

It is hoped to publish fuller details of this work elsewhere.

K. Hellmann

Department of Human Anatomy,
University Museum,
Oxford.
Oct. 11.

[1] Prinzmetal, M., Corday, E., Brill, I. C., Oblath, R. W., and Kruger, H. E., "The Auricular Arrhythmias" (C. C. Thomas, Springfield, Ill.: Blackwell, Oxford, 1953).
[2] Langley, J. N., *J. Physiol.*, 51, 377 (1917).
[3] Hellmann, K., *J. Physiol.*, 120, 41P (1953).

Phenolic Substances of Pear–Apple Hybrids

The leaf of the apple contains as its principal phenolic the glucoside phloridzin. This is present in all *Malus* species examined, together with smaller amounts of the corresponding aglycone phloretin, a quercetin glycoside[1], and traces only of chlorogenic acid and *epi*catechin. Pear leaf, in contrast, contains three phenolics in quantity: chlorogenic and *iso*chlorogenic acids[2] and the glucoside arbutin, with small amounts of catechin, *epi*catechin, flavonol glycosides and hydroquinone, the aglycone of arbutin.

The glucosides phloridzin and arbutin appear to be quite specific in their distribution; in the course of a wide survey of leaves of apple and pear species and varieties by paper chromatography, phloridzin has been found in all apples, but never in pears; conversely, arbutin has been found in all pears but not in apples.

The production of true sexual hybrids between the pear and apple[3] raised the question of the possible dominance of part or all of one phenolic pattern in the hybrid leaf. Through the kindness of the Director of the John Innes Horticultural Institution, it has been possible to examine leaves from a number of different pear–apple hybrids. Because of the limited amount of material available, 70 per cent alcoholic extracts of two-leaf samples were examined by paper chromatography in three different solvent systems; this enabled all the major and some, though not all, of the minor phenolics to be identified.

In all samples, the results indicated addition of the individual phenolic patterns in the hybrids; the leaves contained phloridzin, arbutin, chlorogenic and *iso*chlorogenic acids in quantity, with lesser amounts of phloretin, *epi*catechin and flavonol glycosides. The amounts of each phenolic present varied somewhat among the different hybrids, but in no case were any of the typical phenolics completely absent. In the two triploid hybrids (diploid pear × tetraploid apple), the pear phenolics were relatively weaker than in those hybrids in which both parents were diploid or tetraploid.

This apparently simple addition of the parental phenolic patterns in the hybrids contrasts with the dominant-recessive relationships found with the anthocyanin colouring matters of flowers in intraspecific crosses.

A. H. Williams

Agricultural Research Council
Unit of Plant Nutrition (Micronutrients),
Long Ashton Research Station,
Bristol. Oct. 8.

[1] Bradfield, A. E., and Flood, A. E., Rep. E. Malling Res. Sta. for 1949, 103 (1950). Williams, A. H., "Science and Fruit", 210 (University of Bristol, 1953).
[2] Bradfield, A. E., Flood, A. E., Hulme, A. C., and Williams, A. H. *Nature*, 170, 168 (1952).
[3] Crane, M. B., and Marks, E., *Nature*, 170, 1017 (1952).

Growth of *Chondromyces crocatus* in Pure Culture

The genus *Chondromyces* was named and illustrated, but not described, by Berkeley and Curtis in 1857 in Berkeley's[1] "Introduction to Cryptogamic Botany". It was apparently next seen by Thaxter[2], who reported that he grew it in pure culture. In 1913, this species was stated by Pinoy[3] to grow only in the presence of *Micrococcus*. Beebe[4] reported the presence of *C. crocatus*; but attempts to purify the organism failed completely though it grew readily with various bacteria in mixed culture. Kuhlwein[5] stated that *C. crocatus* could not be grown in pure culture and that it was a symbiotic form. Oetker[6], recently, has shown that several species in the genera *Myxococcus* and *Podangium* can grow upon yeast and algae.

C. crocatus, which may represent the highest morphological and nutritional specialization in the entire order Myxobacteriales, has recently been isolated from soil in our laboratory. The soil sample, obtained in Iowa, consisted of surface debris and soil taken from a permanent bed of rhubarb which, for a number of years, had been heavily fertilized

with chicken manure. The organism was found growing on hay agar plates inoculated with a heavy suspension of soil. It grew very slowly and was not observed for almost six weeks after the streak inoculation had been made. Cysts were removed from the cystophores and inoculated at the centre of crossed streaks of *Escherichia coli, NRRL B*-281, on hay agar. Growth of the *Chondromyces* proceeded in all directions from the point of inoculation. Repeated re-isolations from the advancing edge of growth yielded a 'pure-mixed' culture of *E. coli* and *C. crocatus*. This technique[7] was recommended by Raper for the purification of new isolates of members of the Acrasiales. In these mixed cultures, vegetative development was particularly good along the streaks of living *E. coli* cells. Between the radiating bands of *E. coli*, where the *Chondromyces* was free of the host cells, growth also occurred. When *Chondromyces* cells from these areas were inoculated on a variety of media, no growth could be obtained. In pure-mixed cultures, abnormal fruiting with very limited cyst formation was found to occur only at the edge of the dish. The presence of chance mould contaminants seemed to promote normal cyst formation.

Interest in the mechanism of lysis of the host cells led us to employ a yeast in which the larger cell-size would facilitate microscopic observations. Hence hay agar plates were inoculated in the above fashion with a culture of *NRRL Y*-1656, *Hansenula anomala*. When these were inoculated with cells free of *E. coli*, as described above, growth occurred which was as good as, or better than, with *E. coli* cells. This is the first report to our knowledge of the growth and lysis of yeast cells by any member of this genus, although Oetker[6] recently reported growth on yeast in two other genera of the Myxobacteriales.

Subsequent studies to be published elsewhere on the nutrition of this organism have shown *C. crocatus* can grow not only on live yeast cells but also may be kept in pure culture on autoclaved cells of yeast. It has been carried through many transfers in pure culture in this manner at 24° C. Growth, although not as good, also occurs on the filtrate from yeast cultures from which all yeast cells are removed. Yeast extract, however, has not supported growth. Solidified vitamin B_{12} assay medium with vitamin B_{12} added also failed to support growth. The factor for growth of *Chondromyces* has been found to be present in liver extract and in large quantities in bovine serum. Purity of the culture of *Chondromyces* was determined by inoculating deep liver broth and various other nutrient media as well as direct microscopic examination. Accepting Thaxter's report of the cultivation of this organism in pure culture as accurate, this communication appears to represent the second report of the growth of *C. crocatus* free of all other living organisms.

C. W. Hesseltine
Dorothy I. Fennell
Northern Utilization Research Branch,
Agricultural Research Service,
United States Department of Agriculture,
Peoria, Illinois.
Oct. 1.

[1] Berkeley, M. J., "Introduction to Cryptogamic Botany", 313 (H. Baillierie, London, 1857).
[2] Thaxter, R., *Bot. Gaz.*, **17**, 389 (1892).
[3] Pinoy, E., *C.R. Acad. Sci., Paris*, **157**, 77 (1913).
[4] Beebe, J. M., *Iowa St. Coll., J. Sci.*, **15**, 307 (1941).
[5] Kuhlwein, H., *Arch. f. Mikrob.*, **14**, 678 (1950).
[6] Oetker, H., *Arch. f. Mikrob.*, **19**, 206 (1953).
[7] Raper, K. B., *Quart. Rev. Biol.*, **26**, 169 (1952).

Shape of Bacterial Flagella

In orthodox bacteriology all flagella are curly. With the exception, however, of spirilla, which possess unchanging horny-looking curly appendages (Fig. 1) directly derived from the cell wall[1], motile bacteria usually go forward with a fuzzy-looking straight tail (Fig. 2) and a twisting body[2]. Under various, probably adverse, conditions this straight tail tends to stiffen into a straight clear-cut rod but more often into a clear-cut helix[3]. The straight tail of Fig. 3 actually became the helix of Fig. 4, and the helix of Fig. 5 also arose from a straight tail. The helices may show two different but characteristic wave-lengths in the same bacterium, one always exactly twice the other as in Figs. 4 and 5, for which phenomenon 'biplicity' would appear a suitable term[3].

The transition from straight tail to helix initially is reversible; but after no matter how many reversals the final shape always is the helix. Normal swimming usually continues during these changes, but after them tends to come to a gradual stop, with the bodies becoming rigid. Often the helices then start whirling movements lasting several minutes. These may push a rigid bacterial body about in erratic fashion, or, if the body has stuck, create maelstroms. This anomalous movement has been mistaken for normal motility and as proof that helices are motor-organs. 'Flagella staining' habitually undertaken at this stage naturally shows curly flagella, and in the disfigured dried material 'biplicity' gets lost.

Figs. 3 and 4 illustrate the recent observation that the transition from straight tail to helix is not accompanied by a change in overall length (measured from free tip to body).

Calculation shows that when a straight tail of 10·75 μ overall length changes into a helix of identical overall length, with five windings of a wave-length of 2·15 μ, and an amplitude of *c.* 0·35 μ, the real length of the structure becomes *c.* 12·05 μ, which is an increase of *c.* 12 per cent. A straight tail of 4·9 μ overall length becoming a helix of five windings of the rather short wave-length of 0·98 μ and an amplitude of *c.* 0·35 μ changes its real length from 4·9 μ to *c.* 7·35 μ, an increase of *c.* 50 per cent. These are values from actual measurements.

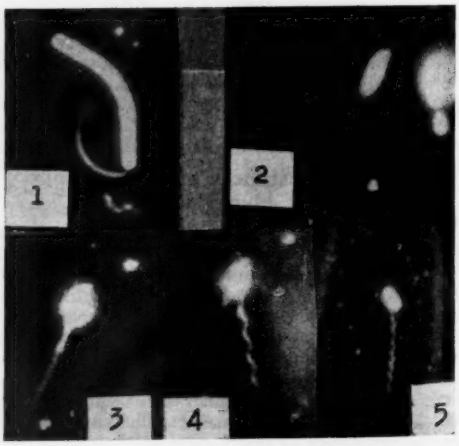


Fig. 1. *Spirillum volutans.* × 1,000
Fig. 2. *Salmonella typhi.* × 1,500
Figs. 3–5. *Salmonella paratyphi B.* × 1,500

How is this helical lengthening brought about? Electron photographs are usually taken at the helical stage and show disorderly masses of submicroscopic wavy fibrils lying around and across bacterial bodies; no straight tail has yet been electron-photographed in the electron microscope.

The transition from straight tail to lengthened helix would seem to necessitate molecular transformations. Such helical rearrangements in the tail might well create tensions or liberate forces capable of setting up the anomalous transient whirling movements described above.

The helix in some bacteria can be seen to split suddenly into a number of thinner similar helices; these may stay terminal, or float about and become distributed over the surface of their own or other bacterial bodies. In this way the so-called monotrichous, lophotrichous and peritrichous types of flagellation are seen to arise. Their common origin is the straight tail, the structure primarily associated with normal motility and which therefore seems entitled to some of the attention so far bestowed on its more elegant curly derivatives.

These observations were all made with the sunlight dark-ground microscopy described previously[3].

ADRIANUS PIJPER

Institute for Pathology,
University of Pretoria. Nov. 10.

[1] Pijper, A., Crocker, C. G., van der Walt, J. P., and Savage, N., *J. Bact.*, **65**, 628 (1953).
[2] Pijper, A., in "The Nature of the Bacterial Surface" (Blackwell, Oxford, 1949).
[3] Pijper, A., and Abraham, G., *J. Gen. Microbiol.*, **10**, 452 (1954).
[4] Pijper, A., *J. Path. Bact.*, **58**, 325 (1946).

Use of Snail Stomach Cytase in Plant Cytology

DURING a study of the large New Zealand fern genus *Blechnum*, it was found virtually impossible to obtain somatic chromosome counts by orthodox methods. This aspect of the problem was about to be abandoned when a paper by Fabergé[1] on the use of snail stomach cytase for maceration in cytology was discovered. There appears to be a general lack of knowledge of this method and its advantages. Manton[2], for example, makes no mention of it.

Well over a thousand root-tip preparations were made by aceto-carmine squash methods with various modifications; but no really satisfactory results were obtained. Fabergé's technique with certain refinements gave outstanding results, almost every preparation yielding good counts (see Fig. 1). Previously adequate spreading had been impossible. The method has been applied to other groups of plants and is showing considerable promise.

Fabergé mentions the possible use of species of snail other than the edible *Helix pomatia* which he utilized. In New Zealand the only snail available in sufficient quantity is the considerably smaller but cosmopolitan species *Helix aspersa* Mueller. With large snails the crop and stomach contents only are used: with small specimens, however, these whole organs are removed and pulverized in a little water. To the extract from about two dozen snails, about 15 ml. of distilled water is added. This is followed by centrifuging at 4,000 r.p.m. for 5 min. The clear brown supernatant liquid is then ready for use. A sample of enzyme if stored in a refrigerator remains effective for at least three batches of root tips. Between uses, any stray cellular material from tissue

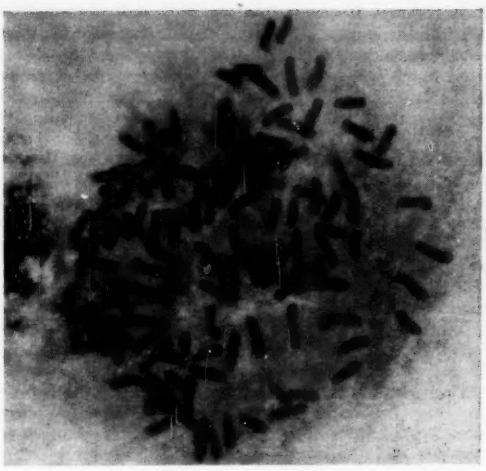


Fig. 1. Root tip preparation from a tetraploid race of *Blechnum fluviatile*, somatic number = 132

previously treated must first be removed by centrifuging. Preliminary tests have shown that the activity of the enzyme complex has a wide temperature-range. The root-tip material is prefixed in a saturated aqueous solution of *p*-dichlorobenzene and then fixed in alcohol – acetic acid (3 : 1 mixture). Before being placed in the enzyme the root-tips are given two changes of a few minutes each in water. Blotting between changes is essential. Over-night treatment in cytase at room temperature is satisfactory (or 3–4 hr. at 25° C. is sufficient). A longer period in cytase tends to make staining more difficult, and the outlines of the chromosomes become diffuse. Lengthy treatment may be useful in studies on coiling, as the coils become more apparent. A rinse in tap-water followed by at least a minute in 45 per cent acetic acid assists the aceto-carmine staining.

It is believed that this method has advantages which deserve wider recognition among cytologists.

T. C. CHAMBERS

Botany Department,
Auckland University College,
New Zealand. Oct. 6.

[1] Fabergé, A. C., *Stain Tech.*, **20**, 1 (1945).
[2] Manton, I., "Problems of Cytology and Evolution in the Pteridophyta" (Cambridge, 1950).

Selective Fertilization following the Use of Sperm Mixtures in the Mouse

ARTIFICIAL insemination has been carried out in the mouse using mixtures of sperm from a number of inbred lines each containing a suitable genetic marker. The lines are *REB* (containing the dominant hair structure gene rex, *ReRe*), *G* (coat colour and pattern tan, $a^t a^t$), and C_3H (coat colour agouti, *AA*); all possible combinations of these genes are phenotypically distinct in the offspring. The first two lines are derived from inbred lines *A* and *CBA* respectively. Sperm is obtained from the vas deferens of killed males and the density of each sample estimated by hæmocytometer counts. Sperm mixtures were made with equal numbers of spermatozoa from each donor; the donor males for each mixture were of approximately the same age. Four types of sperm mixture

Table 1. Total Number of Offspring Born to Date from Mixed-Sperm Inseminations

Females \ Males	Sperm mixtures								
	C_3H	*REB*	*G*	C_3H	*REB*	C_3H	*G*	*REB*	*G*
C_3H				24	4	1	2	5	16
REB	10	1	1	22	4				
G	2	0	0			2	4		
X				23	3	13	4	11	10
Total	12	1	1	69	11	16	10	16	26

Table 2. Litter Analysis of C_3H + *REB* Sperm Mixtures

Sperm mixture No.	Female	Litters: Fertilizing sperm	
		C_3H	*REB*
1	C_3H	4	3
2	C_3H	3	0
3	*REB*	8	2
4	C_3H	2	0
5	*REB*	7	1
	C_3H	5	0
	C_3H	4	0
6	*REB*	5	1
7	*REB*	2	0
8	C_3H	6	1
	X	1	0
	X	0	1
9	*X*	12	2
	X	10	0
Total		69	11

were made, namely, a triple mixture of all three types and three double mixtures containing the three possible pairs of the types. These mixtures were used for inseminating œstrous females of the same three lines. Since fertility was rather low in the inbred lines[1], the same sperm mixtures have also been used on other females taken from highly fertile non-inbred strains. These are referred to as *X* in the tables, which give the results obtained up to the present time.

Certain facts are noteworthy in these results. First, the mixture of *REB* and C_3H sperm produced a significant excess of eggs fertilized by C_3H sperm. This is not due to the death and resorption of the homozygous *REB* animals, because the same result occurs where C_3H are the homozygotes, and also in the non-inbred females. The result has been rather consistent throughout the series of nine such sperm mixtures which have been employed (Table 2). Secondly, in the other two double sperm mixtures there is less evidence of unequal efficiency of, or interaction between, sperm types; though the mixture C_3H and *G*, and the small series from the triple mixture, again suggest that C_3H is slightly more effective. From the triple mixture one tri-paternal litter has been produced[2], an *REB* female having given birth to a litter of five, three derived from the C_3H sperm and one each from *G* and *REB* sperm.

These results clearly show that in sperm mixtures the chance of fertilization by a particular type may not be the same for all components of the mixture. At the present stage in the work, several different interpretations of this fact are possible. It may be that the C_3H sperm is always more efficient than that of the other two lines involved. It may be, however, that the C_3H sperm exerts a specifically depressant effect on *REB* sperm. The experiment is so designed that it should be possible to decide between these two possibilities as more numbers accumulate. One should, further, be able to discover whether there is any tendency for a reaction of one sperm type either with one particular egg type, or with a particular uterine environment, a possibility which should be borne in mind, though there is as yet little sign of it.

This work has been supervised by Dr. R. A. Beatty. I wish to thank Prof. C. H. Waddington for his interest, and the University of Edinburgh for a postgraduate studentship.

R. G. Edwards

Institute of Animal Genetics,
Edinburgh.
Nov. 18.

[1] Snell, D. G., Hummel, K. P., and Abelmann, W. H., *Anat. Rec.*, **90**, 243 (1944).
[2] Edwards, R. G., *Mouse News Letter*, No. 11 (1954).

Role of the Nuclei of the Follicle Cells in the Formation of the Chorion in *Cimex lectularius columbarius* Jen.

The follicular epithelium in insects is said to secrete the chorion after the egg is fully formed. According to Snodgrass[1], the follicular epithelium secretes a substance which is discharged over the fully formed egg and there hardens to form the chorion. Wigglesworth[2] is also of similar opinion. The subject has also been touched upon by Biedermann[3], Cappe de Baillon[4] and Beament[5].

In the course of work on the female reproductive system of the bug *Cimex lectularius columbarius* Jen., collected from the fowl-house of the Indian Veterinary Research Institute, Mukteswar-kumaon, U.P., India, we have found cases in which chorion appeared to be laid down not as an ordinary secretory product of the follicular epithelium, but as something of deeper significance, in which methyl green - staining materials present in the nuclei of the follicular cells were involved.

Ovarioles fixed in Carnoy's fluid and stained with Unna–Pappenheim stain (Fig. 1) revealed that the chorion when it was being laid down consisted of three layers: an inner layer which took up faint pyronine stain; a middle layer which took up methyl green stain; and an outer layer which showed very faint affinity for pyronine. The outer layer sent small spine-like processes outwards, the pointed ends of which were found to be inserted in the nuclei of the follicular cells. Globules deeply stained with methyl green were found migrating from the nuclei

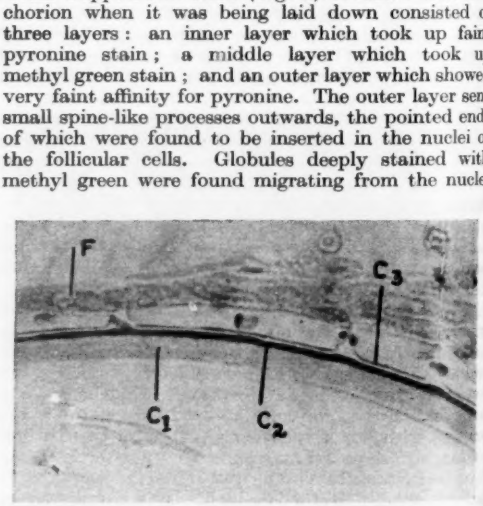


Fig. 1. Microphotograph of a part of a section passing through the ovariole of *Cimex lectularius columbarius* Jen., fixed in Carnoy's fluid and stained with Unna–Pappenheim stain. × 350. *F*, layer of follicular epithelium. C_1, C_2 and C_3, inner, middle and outer layers of chorion respectively. Note the globules stained by methyl green in the spine-like processes of the outer layer (C_3)

of the follicular cells through these spine-like processes into the substance of the developing chorion. The formation of the chorion in this insect was thus found to be due to the direct intervention of the nuclei of the follicle cells, and in this vital process material staining with methyl green (deoxyribonucleic acid) present in the nuclei of the follicle cells assumed the major role.

It is suggested that the whole process of the laying down of the chorion due to nuclear activity is one of short duration, and hence the fixation of the material at the right moment for studying this phenomenon is largely a matter of chance.

The spine-like processes through which the material staining with methyl green travels persist on the outer surface of the fully formed chorion. It may be noted here that these processes were noticed by Cragg[6] in *Cimex lectularius* and in *Cimex rotundatus*. He thought that they served to anchor the egg in position when it was laid.

We gratefully acknowledge the award of a research fellowship by the Indian Council of Agricultural Research to one of us (B. D.).

Added in proof. Fresh material has been subjected to the Feulgen technique. It was found that the middle layer of the chorion which took up methyl-green stain also gave a strongly positive reaction for deoxyribonucleic acid with this technique. The methyl green - staining globules mentioned above were found to be Feulgen positive.

B. Dasgupta
H. N. Ray

School of Tropical Medicine,
Calcutta.
Sept. 17.

[1] Snodgrass, R. E., "Principles of Insect Morphology", 560 (McGraw-Hill, 1935).
[2] Wigglesworth, V. B., "Principles of Insect Physiology", 463 (Methuen, 1950).
[3] Beidermann, W., *Winterstein's Handb. d. vergl. Physiol.*, **3** (1), 497 (1914).
[4] Cappe de Baillon, *C.R. Acad. Sci., Paris*, **196**, 809 (1933).
[5] Beament, J. W. L., *Proc. Roy. Soc.*, B, **133**, 407 (1946); *J. Exp. Biol.*, **23**, 213 (1947).
[6] Cragg, F. W., *Ind. J. Med. Res.*, **8**, 32 (1920).

Rearing Experiments on Marine Teleost Larvæ and Evidence of their Need for Sleep

During a study of the biology of the shore fishes *Blennius pholis* L. and *Centronotus gunnellus* (L.) several series of experiments have been carried out on the rearing of the larvæ. By keeping sufficient eggs in the aquaria it was possible to obtain large numbers of larvæ of similar age. These were evenly distributed between bell-jars which each contained 25 litres of sea water and about fifty larvæ. It was soon found that mechanical stirring by plunger plates as used by previous workers[1] was accompanied by very heavy mortality of the larvæ. The water was therefore kept circulating slowly by gentle streams of small air bubbles. The different batches of larvæ were subjected to various conditions of food and illumination. Larvæ which died were removed daily and percentage survival was used as criterion for comparison between batches. Surviving larvæ grew well, and given suitable conditions a small percentage of these species and of *Cottus scorpius* L. were reared until metamorphosis, when they adopted the demersal habit of the adults.

It seemed desirable to investigate the nutritional value of phytoplankton cultures, which if suitable would give an easy solution to the problem of providing food. Green plant remains have frequently been observed in the stomachs of larval fishes freshly caught from the plankton[2]. Though it has recently been discovered that green pellets found in plaice larvæ from the southern North Sea were fæces of ingested *Oikopleura*[3], it was clearly shown by Gross[4] that herring larvæ kept in the laboratory with cultures of *Chlamydomonas* would fill their guts with green flagellates. This was confirmed with larvæ of *B. pholis*, *C. gunnellus*, *C. scorpius* and *Nerophis lumbriciformis* (Pennant).

On examination under a low-power binocular microscope, the young fishes were seen to show a rhythmic peristalsis, which started at the posterior end of the pharynx and travelled posteriorly down the whole length of the narrow œsophagus. This swallowing movement was most easily seen in *Centronotus* larvæ, because of their straight gut and slight pigmentation. Particles suspended in the sea water were taken in slowly through the open mouth, became arranged in a linear fashion in the narrow œsophagus, and then were forced posteriorly by the peristaltic movements. No strong current into the mouth was observed when the fishes were under observation in small dishes; but it seems likely that water is taken in more readily during the course of swimming, for larvæ kept in rearing jars usually had their guts visibly coloured by algal cells, although these were supplied in only moderate concentration.

Nevertheless, the large quantities of flagellates and diatoms ingested did not have a markedly beneficial effect upon survival of these larvæ. Cultures of *Chromulina pusilla* Butcher, *Isochrysis galbana* Parke, *Chlamydomonas* sp., *Chlorella stigmata* Butcher, and *Prorocentrum micans* Ehrenberg were tried separately in the laboratory with larvæ of *Centronotus*, but the resulting survival-rate was at most only slightly greater than in the larvæ kept without food. Similar results were obtained with *B. pholis* (Fig. 1, *A* and *B*). When these flagellates and diatoms were offered together with nauplii of barnacles and *Artemia*, survival was not significantly better than in larvæ fed on nauplii alone. Experiments on these lines are still in progress and it may be possible eventually to demonstrate that phytoplankton organisms have some slight value as food, but it is clearly impossible to rear the larvæ on such organisms alone. The ingestion of such organisms is probably connected with the

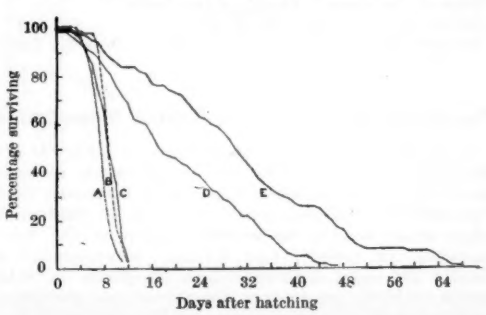


Fig. 1. *A*, without food, continuous light; *B*, with flagellates, continuous light; *C*, with *Artemia* nauplii, continuous darkness; *D*, with *Artemia* nauplii, continuous light; *E*, with *Artemia* nauplii, alternate light and darkness

drinking of water for osmo-regulation, as demonstrated by Homer Smith[5] in marine teleosts.

Feeding on nauplii, on the other hand, involves deliberate efforts of catching by the larvæ, and they were seen doing this only in the light. Larvæ examined after they had been kept in continuous darkness always had empty stomachs, though they had been supplied with abundant nauplii. Their survival-rate was no more than that of larvæ kept without food (Fig. 1, *A* and *C*). When the only source of illumination was a dim red light, the larvæ of *B. pholis* did not feed but became inactive, and generally remained suspended in the water. Close examination, combined with experiments involving changes of pressure, revealed the presence of a swim bladder with a hydrostatic function, which is absent in adults of this species[6]. The inactivity of the larvæ, which is presumably shown every night, recalled previous accounts of sleeping in fishes[7].

The question of whether such sleep is beneficial was then investigated. Five jars with almost equal numbers of larvæ of *B. pholis* were given 7–8 hr. of illumination during the day and kept in darkness during the night. The same number of jars were kept under continuous illumination. Abundant *Artemia* nauplii were supplied as food to all the jars, particular care being taken to ensure that the larvæ kept under continuous illumination always had plenty of nauplii available as food. Other environmental conditions were equal, and the larvæ were of similar parentage; yet after a few days it was clear that those kept under alternate light and darkness were surviving much better than those under continuous illumination (Fig. 1, *D* and *E*). The rates of survival showed only slight deviations from the mean in all five jars of each batch. After a period of inactivity in the dark, larvæ exposed to light become particularly active, showing more vigorous feeding on nauplii than those kept illuminated all the time.

S. Z. Qasim

Marine Biology Station,
University College of North Wales,
Bangor.
Oct. 5.

[1] Garstang, W., *J. Mar. Biol. Assoc. U.K.*, **6**, 70 (1900). Lebour, M. V., *J. Mar. Biol. Assoc. U.K.*, **13**, 721 (1923).
[2] Lebour, M. V., *J. Mar. Biol. Assoc. U.K.*, **11**, 433 (1918); **12**, 22 (1919); **12**, 261 (1920); **12**, 458 (1921). Hardy, A. C., "Fish. Invest.", **7**, 1 (1924). Ogilvie, H. S., "Fish. Scot., Sci. Invest.", **1**, 1 (1927). Marshall, S. M., Nicholls, A. G., and Orr, A. P., *J. Mar. Biol. Assoc. U.K.*, **22**, 245 (1937).
[3] Shelbourne, J. E., *J. Mar. Biol. Assoc. U.K.*, **32**, 149 (1953).
[4] Gross, F., *J. Mar. Biol. Assoc. U.K.*, **21**, 753 (1937).
[5] Smith, H. W., *Amer. J. Physiol.*, **93**, 480 (1930).
[6] Plattner, W., *Rev. suisse Zool.*, **48**, 201 (1914).
[7] Boulenger, G. A., and Bridge, T. W., "Camb. Nat. Hist.", **7**, 637 (1910).

Population Regulation in Rabbit Nematodes

Comparatively little information is available on the factors governing the size of nematode infestations in wild mammals. Elton *et al.*[1] showed that infestations of *Nematospiroides dubius* in field-mice (*Apodemus*) tended to become larger as the host increased in weight, and Evans[2] demonstrated a similar tendency for *Graphidium strigosum* in wild rabbits (*Oryctolagus*); but for *Passalurus ambiguus* he found that, after rabbits reached a weight of 3½ lb., infestations declined with further increase in host-weight. The authors interpreted their results as indicating the effects of increasing age of host.

Recent work on the parasites of the wild rabbit (*Oryctolagus cuniculus* L.) in New Zealand gives confirmation of Evans's results for *G. strigosum*, and provides the first adequate picture of population-size in *Trichostrongylus retortaeformis*, a picture which differs markedly from those of the other nematodes mentioned above and forms the subject of the present communication.

The size of worm populations was estimated by a dilution-sampling technique[3]; the presence or absence of infective larvæ in the sample was noted, but all later stages were counted. The paunched weight of the host is used as an indication of age, but as such it is only reliable for rabbits weighing less than 1,000 gm., all such animals being less than 9½ months old[4]. Heavier weight groups contain individuals of varying age; but the proportion of animals more than 9½ months old increases with weight, so that there is an increase in the mean age of the sample in each successive weight-group.

Fig. 1 shows the frequency of occurrence of infestations of different size of *T. retortaeformis* in relation to the paunched weight of the host. The results were obtained from the examination of 1,055 rabbits collected over a period of 13 months (March 1950–March 1951 inclusive) in the Tikokino district of Hawke's Bay Province (North Island of New Zealand). The figures for size of infestation represent one-tenth of the total population (the proportion actually counted), and have been grouped on a logarithmic scale because the range of variation is rather wide.

The most striking feature is the very great range in the size of infestations, and this is evident in every

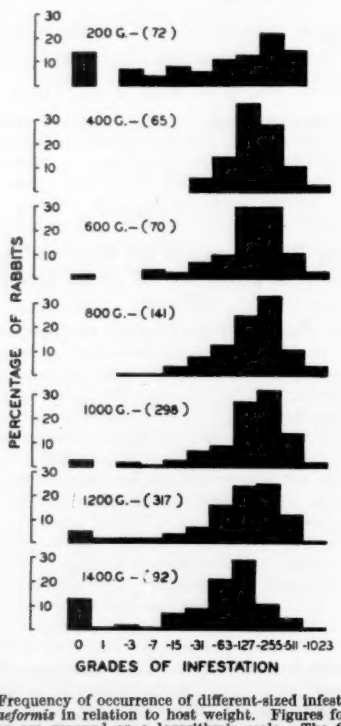


Fig. 1. Frequency of occurrence of different-sized infestations of *T. retortaeformis* in relation to host weight. Figures for size of infestation are grouped on a logarithmic scale. The figures in brackets refer to the number of rabbits in each 200-gm. weight-group, starting from a paunched weight of 200 gm.

weight-group except the second one (400–599 gm.), which is based on a slightly smaller sample than the others. Heavy infestations were found in some rabbits in every weight class, the largest number of worms counted in one rabbit (paunched weight 1,156 gm.) being 937, which indicates a total population of some nine or ten thousand worms. The proportion of heavy infestations rises abruptly from the first to the second weight-group, due presumably to the greater chance of acquiring worms as the young rabbits change their diet from milk to grass. After this point there is little further increase but, on the contrary, a tendency for light infestations to reappear. These facts suggest that heavy infestations are acquired quite early in the life of the rabbit and that there is some mechanism preventing the animal acquiring progressively heavier infestations as it grows older. A second point of interest in Fig. 1 is that light infestations become increasingly frequent in the heavier rabbits until, in the 1,400 gm. weight-class, 12 per cent of the animals had no worms other than infective larvæ.

The data presented are probably adequate to give a true picture of *T. retortaeformis* infestations in Hawke's Bay rabbits during 1950–51; but there is evidence suggesting that in some circumstances much higher infestations may occur. For example, among 74 rabbits collected at the Auckland Islands (200 miles south of New Zealand) in March 1954, seven had populations exceeding any recorded in Hawke's Bay. The largest number of worms counted in one rabbit was 1,920, which is double the highest Hawke's Bay figure. The tendency towards a higher proportion of light infestations among the heavier rabbits was even more marked in the Auckland Islands than in Hawke's Bay.

The 'self-cure' mechanism described by Michel[5] for *T. retortaeformis* in laboratory rabbits provides a satisfactory explanation for the fact that in most of the classes (Fig. 1) some rabbits contain no worms other than infective larvæ. The alternative explanation that the wide range in the size of infestations is matched by an equally wide range in natural resistance among individual rabbits appears less likely, and lacks any experimental support. Accepting the 'self-cure' mechanism, and comparing the infestations found in Hawke's Bay with those at Auckland Islands, it is apparent that 'self-cure' may operate at different levels of worm infestation in different rabbit populations. This conclusion leads to the suggestion that the abundance of *T. retortaeformis* is governed by the resistance of the host, which in turn may be modified by various environmental factors such as the host's food supply[6]. Thus any effect the parasite may have in controlling the numbers of the host is secondary and perhaps additional to that of the environment.

Elton *et al.*[1] concluded that, since the highest infestations of *N. dubius* occurred in the oldest mice, any increase in the host population by reproduction, and thus a lowering of the average age, causes a reduction in the mean number of parasites per host, thereby reducing the possibility of the parasite acting as a check to the further increase of the host population. The present work shows that such a concept would be applicable to *G. strigosum* in rabbits, but not to *T. retortaeformis*, severe infestations of which are common in quite young rabbits.

A final conclusion emerging from the present work is that, since abundance of parasites is strongly correlated with age of host (*G. strigosum*) and locality of collection (*T. retortaeformis*), records of parasite abundance in wild animals are of little significance unless linked with details of age composition and locality of collection of the host sample.

The observations on which this communication is based, together with comparable material on other rabbit parasites, will be published in full elsewhere.

P. C. Bull

Animal Ecology Section,
Department of Scientific and Industrial Research,
Wellington, New Zealand.

Sept. 22.

[1] Elton, C., Ford, E. B., Baker, J. R., and Gardner, A. D., *Proc. Zool. Soc. Lond.*, 657 (1931).
[2] Evans, W. M. R., *Parasitology*, **32**, 67 (1940).
[3] Bull, P. C., *N.Z. J. Sci. Tech.*, B, **34**, 341 (1953).
[4] Watson, J. S., and Tyndale-Biscoe, C. H., *N.Z. J. Sci. Tech.*, B, **34**, 427 (1953).
[5] Michel, J. F., *Nature*, **169**, 933 (1952).
[6] Stewart, D. F., and Gordon, H. McL., *Aust. J. Agric. Res.*, **4**, 340 (1953).

Absorption Spectrum of Deeply Coloured *Cyclo*pentadiene Polymers

*Cyclo*pentadiene can be converted, catalytically by trichloroacetic acid (H*A*), into a brown-red poly-*cyclo*pentadiene trichloroacetic acid ester (I). The colour of this adduct is due to conjugated double bonds[1], which are also responsible for its proton acceptor properties[2], namely, for the fast reversible reaction:

$$(\mathrm{I}) + (\mathrm{H}A) \rightleftharpoons (\mathrm{II}), \qquad (1)$$

where (II) is a blue salt-like adduct, formed by transfer of a proton from (H*A*) to (I).

We have developed a technique by which the conversion of *cyclo*pentadiene into (I) or (II) can be carried out at oxygen pressures less than 10^{-3} mm. mercury, and by which the light absorption, in the range 2500–30,000 A., could be measured without admitting oxygen to the reaction mixture. Absorption bands of (I) of wave-length greater than 3500 A. could not be detected, but (II) has a characteristic spectrum in the visible range as shown by curve (*a*) in Fig. 1; this experiment was carried out at a trichloroacetic acid concentration sufficiently high to

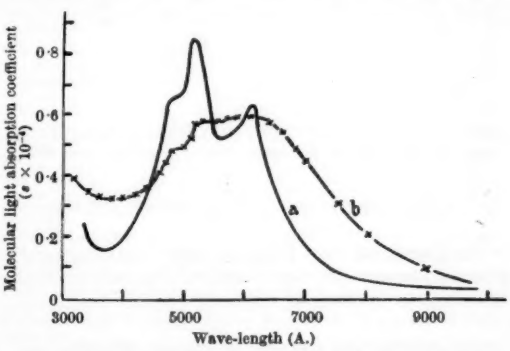


Fig. 1. Solvent benzene, temperature 20·0° C.; trichloroacetic acid concentration, 1·65 gm.mol./l.
Curve (*a*), oxygen excluded; measurement carried out 20 hr. after start of reaction; polymer concentration, $11{\cdot}3 \times 10^{-4}$ number average gm.mol./l.; optical path-length, 0·102 cm.
Curve (*b*), ratio of mol. oxygen to mol. *cyclo*pentadiene at zero time is 1·2; measurement carried out 24 hr. after start of reaction; polymer concentration $6{\cdot}44 \times 10^{-4}$ number average gm.mol./l.; optical path-length, 0·205 cm.

shift the equilibrium of reaction (1) completely to the right-hand side. On addition of oxygen, the spectrum of (II) is fundamentally altered. The various ε-values depend, *inter alia*, on the time of exposure to oxygen and on its partial pressure. The spectrum of oxidized (II), for specified experimental conditions, is shown by curve (*b*). The molar light absorption coefficient, ε, is defined by optical density/optical path-length × *c*, where *c*, the polymer concentration, is calculated from the initial concentration of *cyclo*pentadiene and the number average degree of polymerization specified before[1].

Spectrophotometric tests, in the range 4500–6500 A., were carried out continuously during the conversion of the monomer and it was possible, therefore, to study by an optical method the gradual building up of this coloured polymer. The results of these experiments will be discussed elsewhere.

C. F. Blakely
A. Wassermann
William Ramsay and Ralph Forster Laboratory,
University College,
London, W.C.1.

[1] *Nature*, **168**, 459 (1951).
[2] *Nature*, **172**, 73 (1953).

Mechanism of Osazone Formation

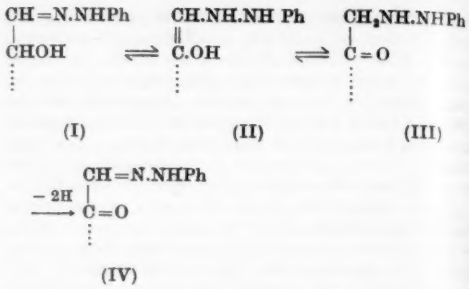
A fact which seems to have escaped attention in formulating a mechanism for osazone formation is that β-alkyl substituted phenylhydrazines are oxidized very readily in air to form phenylhydrazones[1]:

$$R.CH_2.NH.NH.Ph. \xrightarrow{Air} R.CH{=}N.NH.Ph.$$

Further, it has been found recently[2] that β-acetonyl phenylhydrazine is also oxidized by air at room temperature extremely readily:

$$CH_3.CO.CH_2.NH.NH.Ph. \xrightarrow{Air} CH_3.CO.CH{=}N.NH.Ph.$$

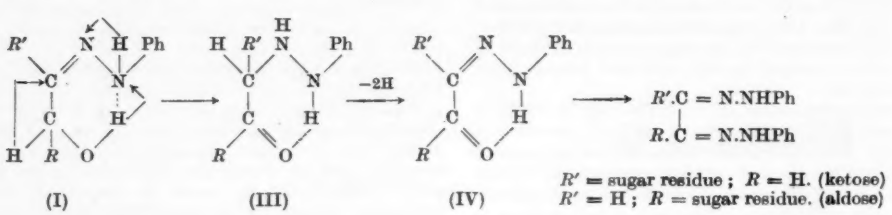
Here, it seems, is an important clue for detecting the mechanism of osazone formation, since if, as Weygand suggested[3], an Amadori rearrangement (I → III) is assumed:



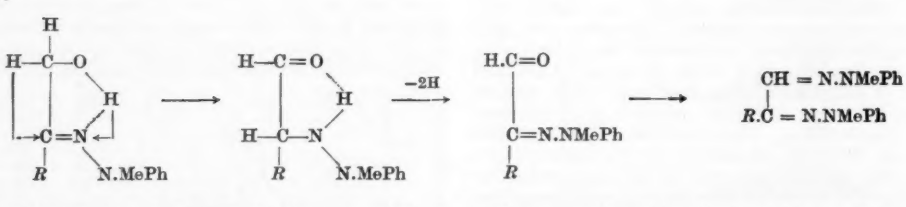
then it is no longer necessary to search for an oxidizing agent to convert (III) into (IV). All that is required is a hydrogen acceptor such as oxygen, or the phenylhydrazonium cation[4], which is reductively cleaved to aniline and ammonia.

This mechanism will accommodate all the known facts on osazone formation, including the observation of Orning and Stempel[5] that the reaction is inhibited at 30° C. in the absence of air. Since oxygen and the phenylhydrazonium cation are competing hydrogen acceptors, one would expect to find a correlation between the yield of aniline (and ammonia) and the quantity of oxygen present.

The formation of osazones and methylphenylosazones may proceed through the hydrogen bonded structures shown below:



or,



Two suggestions have been put forward[6] to explain why the reaction is not continued to C_3 of the sugar residue, but a choice between these must await further experimental evidence.

Vincent C. Barry
P. W. D. Mitchell
Laboratories of the
Medical Research Council of Ireland,
Trinity College, Dublin. Sept. 17.

[1] Grammatacakis, *C.R. Acad. Sci., Paris*, **204**, 1262 (1937); **210**, 303 (1940).
[2] Mitchell (in the press).
[3] Weygand, *Ber.*, **73**, 1259 (1940).
[4] Kenner and Knight, *Ber.*, **69**, 341 (1936). Braude and Forbes, *J. Chem. Soc.*, 1763 (1951). Bloink and Pausacker, *J. Chem. Soc.*, 661 (1952).
[5] Orning and Stempel, *J. Org. Chem.*, **4**, 410 (1939).
[6] Percival, "Adv. Carbohydrate Chem.", **3**, 43 (1948). Fieser and Fieser, "Organic Chemistry", 351 (D. C. Heath and Co., Boston, 1944).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Tuesday, February 1

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Donald Wallis: "A Critical Review of Some Human Factors in the Design of Machine Controls".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. E. Fogg: "The Use of Microscopic Plants in the United States".*

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. E. F. Gale: "Actions of Antibiotics on Bacteria".* (From a series of lectures on "The Scientific Basis of Medicine".)

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (joint meeting with the LONDON SECTION, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. W. C. Wake: "Surface Chemistry and Adhesion".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion meeting—"Colour from the Viewpoint of the Painter and the Scientist". Chairman: Prof. T. A. Stephenson, F.R.S.; Speakers: Mr. G. J. R. Frankl and Prof. W. D. Wright.

Wednesday, February 2

GEOLOGICAL SOCIETY OF LONDON (joint meeting with the ROYAL ASTRONOMICAL SOCIETY, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Origin of the Earth". Chairman: Prof. W. B. R. King, F.R.S. Speakers: Prof. L. Hawkes, F.R.S., Mr. T. Gold, Prof. C. E. Tilley, F.R.S., and Sir Edward Bullard, F.R.S.

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Continued Discussion on "The Beaver Report of the Committee on Air Pollution".

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Prof. G. Schwarzenbach (Zurich University): "The Complexones and their Analytical Application".

UNIVERSITY OF LONDON (at the Institute of Laryngology and Otology, Royal National Throat, Nose and Ear Hospital, Gray's Inn Road, London, W.C.1), at 6 p.m.—Prof. M. Arslan (Padua): "The Effects of Ultra Sonic Waves on the Ear".*

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Mr. J. Eccles: "The Generation of Electricity in Britain".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the SOUTH-WEST ESSEX TECHNICAL COLLEGE CHEMICAL SOCIETY, at the South-West Essex Technical College, Walthamstow, London, E.17), at 7 p.m.—Mr. L. C. Nickolls: "Some Chemical Aspects of Forensic Science".

Thursday, February 3

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. M. Rosenberg: "The Thermal Conductivity of Metals at Low Temperatures"; Mr. R. W. Ditchburn: "Absorption Coefficients in the Vacuum Ultra-Violet. Part 3—Methane".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. W. S. Pringle, F.R.S.: "The Evolution of Song in Cicadas".

UNIVERSITY OF LONDON (at the Institute of Psychiatry, Maudsley Hospital, London, S.E.21), at 5 p.m.—Prof. H. J. Eysenck: "Psychology and the Foundations of Psychiatry".*

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. O. K. Mawardi: "On Heat Maintained Oscillations".

UNIVERSITY OF LONDON, BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. P. B. Medawar, F.R.S.: "Tissue Transplantation Immunity". (From a series of lectures on "The Scientific Basis of Medicine".)*

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. W. E. Hoare: "Tin and Tinplate".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, February 4

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the MANCHESTER SECTION and the FOOD GROUP, in the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Meeting on "Some Aspects of Air Conditioning in the Bakery and Textile Industries".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. J. A. Scott: "Health". (From a series of University Extension lectures on "Aspects of Social Policy".)

BRITISH GLACIOLOGICAL SOCIETY (at the School of Geography, Mansfield Road, Oxford), at 8.15 p.m.—Mr. G. T. Warwick: "Ice and Caves".

UNIVERSITY OF LONDON (at Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Brigadier Sir John Hunt: "The British Mount Everest Expedition 1953".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. V. B. Wigglesworth, F.R.S.: "The Control of Metamorphosis in an Insect".

Saturday, February 5

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. C. von Fürer-Haimendorf: "The Sherpas of the Nepal Himalaya".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER (with a degree in agriculture or equivalent qualification and sound experience in practical farming, and, if possible, in teaching) IN AGRICULTURE, at the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (February 3).

HEAD (graduate (preferably science) and with administrative experience) OF THE DEPARTMENT OF SCIENCE AND GENERAL EDUCATION—The Principal, London School of Printing and Graphic Arts, Back Hill, London, E.C.1 (February 4).

TECHNICIAN (skilled machinist and/or instrument maker, and preferably with some experience of servicing X-ray therapy equipment) IN THE PHYSICS DEPARTMENT WORKSHOP—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex (February 4).

SENIOR SCIENTIFIC OFFICER (with a university degree of high standard in electrical engineering or physics, with mathematics or mathematical physics to final honours standard or equivalent qualifications, and several years experience of research in the above or an allied field) in the Department of Supply, Aeronautical Research Laboratories, Fishermen's Bend, Victoria, Australia, to be responsible for the investigation of instrumentation schemes in the field of aeronautical research, and detailed investigation of resultant problems and the subsequent development of necessary apparatus—The Senior Representative (AP.24), Department of Supply, Australia House, Strand, London, W.C.2 (February 5).

BOTANIST (preferably with experience in microscopy) for work connected with the effect of field factors on fruit characters, especially those affecting the storage life of apples—The Secretary, East Malling Research Station, near Maidstone, Kent (February 7).

ASSISTANT ADVISORS (with an honours degree in anthropology and administrative experience) ON ABORIGINES in the Federation of Malaya—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.167/60/02 (February 8).

SENIOR LECTURER (with good qualifications and recent teaching experience, in either physics or chemistry) IN SCIENCE—The Secretary, Homerton College, Cambridge (February 10).

SENIOR LECTURER, Grade 1 or 2 (with a good honours degree) IN PHYSICS, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (February 14).

SCIENTISTS (with a first- or second-class honours degree in physics, engineering, mathematics or statistics, and experience in field, laboratory, or operational research, and preferably with experience in the writing of research reports) IN THE FIELD INVESTIGATION GROUP—The National Coal Board, Establishments (Personnel), Hobart House, London, S.W.1, quoting TT/914 (February 15).

LECTURER IN ANIMAL PRODUCTION at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 17).

CHIEF LECTURER or SENIOR LECTURER IN VETERINARY CLINICAL MEDICINE, and a SENIOR LECTURER or LECTURER (Grade 1) IN VETERINARY CLINICAL MEDICINE, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 19).

UNIVERSITY DEMONSTRATOR IN PHYSICS—Dr. F. B. Kipping, Chemical Laboratory, Pembroke Street, Cambridge (February 19).

HEADMASTER (graduate of a British university and with sound experience of agricultural education) OF THE BRYMORE SECONDARY TECHNICAL SCHOOL OF AGRICULTURE, Cannington, near Bridgwater, Somerset—Chief Education Officer, County Education Office, Truli Road, Taunton, Somerset (February 21).

LECTURER IN PLANT PATHOLOGY; a LECTURER/SENIOR LECTURER IN BACTERIOLOGY; a LECTURER/SENIOR LECTURER IN PSYCHOLOGY; and a SENIOR LECTURER IN EDUCATION, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 26).

READER or SENIOR LECTURER (with special qualifications in chemical pathology) IN CHEMICAL PATHOLOGY—The Registrar, The University, Manchester 13 (February 26).

SYSTEMATIC BOTANIST (preferably with research interests in quantitative and experimental taxonomy), at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 26).

HEAD (with high qualifications in geology and experience in both teaching and research) OF THE DEPARTMENT OF GEOLOGY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (February 28).

LECTURER IN THE DEPARTMENT OF LOGIC AND METAPHYSICS—The Secretary, The University, Edinburgh (February 28).

LECTURER (with an honours degree in physiology, and with experience in teaching experimental physiology to honours students) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (February 28).

Senior Lecturer in Physical Chemistry at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, March 1).

I.C.I. Research Fellows (2) in Physics, Chemistry, Pharmacology, Metallurgy, Engineering, Geology or Agricultural Science, or an allied subject—The Registrar, University of Wales, University Registry, Cathays Park, Cardiff (March 31).

Plant and Animal Quarantine Officer (with a university degree with good scientific qualifications and mature experience in the field of plant or animal pests or diseases and their control and prevention, including quarantine measures), with the South Pacific Commission at Noumea, New Caledonia, to carry out investigations, etc., relating to the control of plant and animal pests, diseases, and weeds in the South Pacific, including supervision of a rhinoceros beetle research programme, operation of an information centre and reporting service, and improvement of control and protective measures—The Secretary-General, South Pacific Commission, Noumea, New Caledonia (March 31).

Lecturer (with an honours degree in botany or agricultural botany, and preferably with postgraduate experience in plant physiology, ecology, genetics or virus pathology) in the Department of Agricultural Botany—The Registrar, The University, Reading (April 15).

Turner and Newall Research Fellows in Engineering, Inorganic Chemistry, Physics, and allied subjects—The Registrar, The University, Manchester (April 30).

Agronomist. Scientific Officer or Senior Scientific Officer grade (with at least a second-class honours degree with not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical tree crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, to assist in laying down field experiments on various methods of cultivating cocoa—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/200/05.

Assistant or Associate Professor of Statistics, and a Sessional Lecturer in Mathematics—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Alberta, Canada.

Chemist or Biochemist (with a good honours degree) in the Technical Division for administrative work which is concerned with the assessment and development of inventions in chemical and biochemical fields—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

Chemist (with two or three years experience in research or industry) for physical and chemical research relating to textile industrial operation—The Personnel Officer, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ontario, Canada.

Deputy Director (with high academic qualifications, wide experience in engineering research, and preferably some administrative ability and a knowledge of the motor industry) of the Motor Industry Research Association—The Director, Motor Industry Research Association, Lindley, near Nuneaton, Warwickshire.

Laboratory Steward (with recognized qualifications and with a special interest in physics)—The Registrar, Hatfield Technical College, Roe Green, Hatfield, Herts.

Lecturer in Education—The Principal, The Training College, Bingley, Yorks.

Physical Chemist (with a good honours degree and some research experience (not necessarily in textiles)), to carry out research on dye absorption by textile materials—The Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

Physicists, Chemists, Chemical Engineers and Mechanical Engineers—National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, quoting TT/913.

Reader in Physics, and Senior Lecturers or Lecturers (3) in Physics—The Dean, College of Arts and Science, Baghdad, Iraq.

Research Assistant to design and construct research electronic equipment and assist in its use—The Director, Chemistry Department, The University, Birmingham 15.

Scientific Officers (with a first- or second-class honours degree or equivalent in mathematics, physics or economics), in or near London, for operational research under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.384/54A.

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

The Registrar General's Statistical Review of England and Wales for the year 1953. Tables. Part 1: Medical. Pp. x+366. (London: H.M. Stationery Office, 1954.) 10s. net. [1911

Ministry of Food. Domestic Food Consumption and Expenditure, 1952. Annual Report of the National Food Survey Committee. Pp. 102. (London: H.M. Stationery Office, 1954.) 4s. net. [1911

Colonial Office. Colonial Road Problems: Impressions from Visits to East Africa and Northern Rhodesia. By H. W. W. Pollitt. (Colonial Research Publications—No. 17.) Pp. vi+77+26 plates. (London: H.M. Stationery Office, 1954.) 10s. net. [1911

General Register Office. Studies on Medical and Population Subjects. No. 8: Measurement of Morbidity—a Report of the Statistics Sub-Committee of the Registrar General's Advisory Committee on Medical Nomenclature and Statistics. Pp. iii+12. (London: H.M. Stationery Office, 1954.) 1s. 6d. net. [1911

Federation of British Industries. A Career for the Graduate in Industry. Pp. ii+24. 2s. Industry and the Graduate. Pp. ii+31. 2s. (London: Federation of British Industries, 1954.) [1911

Ministry of Agriculture and Fisheries. Fishery Investigations, Series 2, Vol. 18, No. 6: The Biology and Dispersal of *Mytilicola intestinalis* Steuer: a Copepod Parasite of Mussels. By G. C. Bolster. Pp. 30+2 plates. (London: H.M. Stationery Office, 1954.) 6s. net. [1911

Report of the Ministry of Health for the year ended 31st December, 1953. Part 2: On the State of the Public Health—being the Annual Report of the Chief Medical Officer for the year 1953. (Cmd. 9307.) Pp. vi+262. (London: H.M. Stationery Office, 1954.) 7s. 6d. net. [1911

Royal Astronomical Society. List of Fellows, Junior Members and Associates, 1954 June. List of Persons to whom the Medals or Testimonials of the Society have been Adjudged. George Darwin Lecturers. Presidents and Officers of the Society. Pp. 28. (London: Royal Astronomical Society, 1954.) [1911

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations. Season 1953–54. Aden Protectorate—Abyan Cotton Experiment Station. By R. R. Anson. Pp. 5. 9d. Cotton Research Station, Namulonge. By J. B. Hutchinson. Pp. 8. 9d. Anglo-Egyptian Sudan—Cotton Breeding Stations. Introductory Note by R. L. Knight and M. F. Rose. Pp. 22. 9d. Kenya—Nyanza Province. By M. S. Hastie. Pp. 6. 9d. (London: Empire Cotton Growing Corporation, 1954.) [1911

British Intelligence Objectives Sub-Committee Surveys. Report No. 34: The German Plastics Industry during the Period 1939–1945. By Dr. N. J. L. Megson and H. J. E. Poupard. Pp. 146+16 plates. (London: H.M. Stationery Office, 1954.) 6s. net. [1911

Report of the Proceedings of the Fourth International Conference on Planned Parenthood, Stockholm, 17–22 August, 1953. Pp. xxiii+200. (London: International Planned Parenthood Federation, 1954.) 10s. 6d; 6 D. marks; 900 lire; 2 dollars. [1911

Other Countries

Berichte des Deutschen Wetterdienstes. Nr. 13 (Band 2): Die Optik und Meteorologie der Atmosphärischen Trübung. Von Fredrich Volz. Pp. 47. (Bad Kissingen: Deutschen Wetterdienstes, 1954.) [1911

Conseil Permanent International pour l'Exploration de la Mer. Charlottenlund Slot, Danemark. Rapports et Procès-Verbaux des Réunions. Vol. 136 (1953): Contributions to Special Scientific Meetings, 1953. Pp. 102. (Copenhague: Andr. Fred. Høst et Fils, 1954.) 19 kronor. [1911

Durban Museum Novitates. Vol. 4, Part 7: Some Scarabaeina in the Durban Museum and Art Gallery. By Maria C. Ferreira. Pp. 91–96. Vol. 4, Part 8: Eine Neue Trox-Art aus Süd-Afrika. Von Dr. E. Haaf. Pp. 97–100. Vol. 4, Part 9: Miscellaneous Taxonomic Notes on African Birds. By P. A. Clancey. Pp. 101–118. (Durban: Durban Museum and Art Gallery, 1954.) [1911

Thirty-Seventh Annual Report of the National Research Council of Canada, 1953–54, including the Annual Report of Canadian Patents and Development, Limited. Pp. 50. (N.R.C. No. 3286.) (Ottawa: National Research Council, 1954.) [1911

Transactions of the Royal Society of South Australia. Vol. 77—Centenary Volume. Pp. xiv+221+4 plates. (Adelaide: Royal Society of South Australia (Inc.), 1954.) 42s. [1911

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1953. Von E. Rübel and W. Lüdi. Pp. 81. (Zürich: Geobotanische Forschungsinstitut Rübel in Zürich, 1954.) [1911

Memorie dell' Instituto Italiano di Idrobiologia "Dott. Marco de Marchi". Vol. 8. Pp. 322. (Milano: Editore Ulrico Hoepli, 1954.) [1911

Department of Agriculture, Jamaica. Extension Circulars. No. 50: Caterpillar Outbreaks. By Dr. H. C. James. Pp. 12+1 plate. No. 51: Keep Your Land Free from Piano Grass. By M. S. Motta. Pp. 5. No. 52: The Maintenance of Farm Machinery. By W. E. Mitchell. Pp. 18. No. 53: Profitable Production of Corn in Jamaica. By C. W. Hewitt. Pp. 8. No. 54: Care and Management of Bulls. By G. E. Redshaw. Pp. 13. No. 55: Diseases of Rabbits. Pp. 8. Bulletin No. 51 (New Series): Sample Survey of Condensery Supplies, 1951–52. By W. D. Burrowes. Pp. 26. 1s. Bulletin No. 52 (New Series): Infertility of Cattle in Jamaica: a Report on a Visit to Jamaica, September–October, 1952. By S. L. Hignett. Pp. 1+20. 2s. Annual Report of the Department of Agriculture for the year ended 31st December, 1952. Pp. 41. 3s. (Kingston, Jamaica: Department of Agriculture, 1953 and 1954.) [1911

Bulletin of the American Museum of Natural History. Vol. 105, Article 1: The Systematic Position of *Lanthanotus* and the Affinities of the Anguinomorphan Lizards. By Samuel Brooker McDowell, Jr., and Charles M. Bogert. Pp. 142+16 plates. (New York: American Museum of Natural History, 1954.) 3 dollars. [1911

Basket Maker II Sites Near Durango, Colorado. By Earl H. Morris and Robert F. Burgh. (Publication 604.) Pp. x+135+73 plates. (Washington, D.C.: Carnegie Institution of Washington, 1954.) 4.25 dollars, paper; 4.75 dollars, cloth. [1911

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world.

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1.
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office